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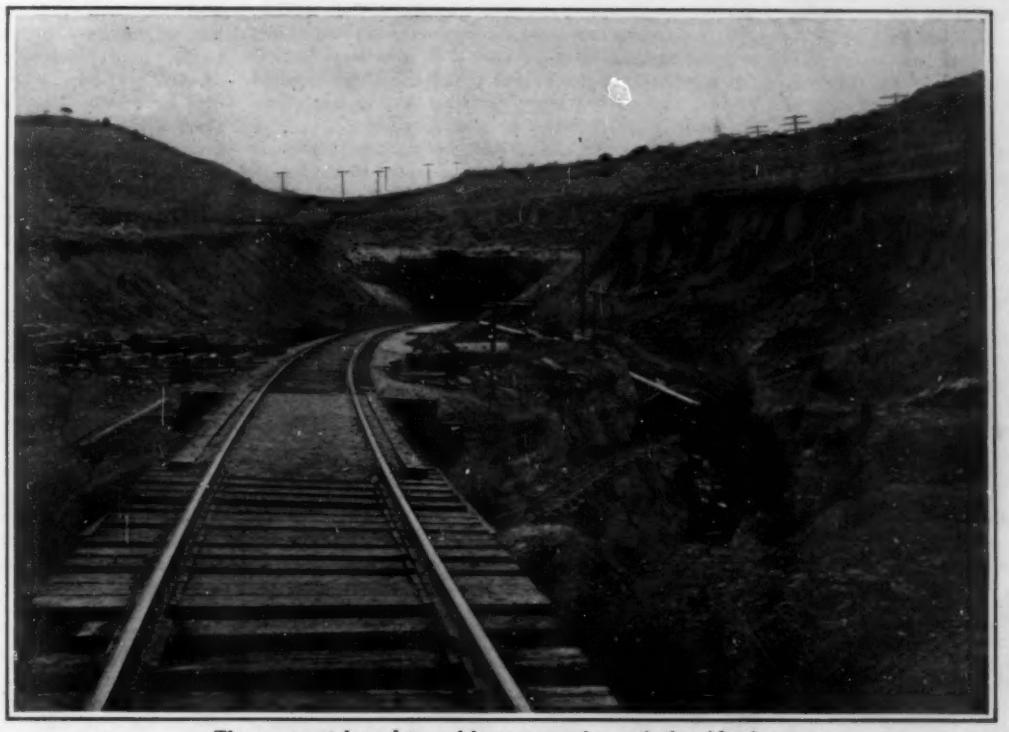
Double-Tracking a Railroad Through a Mountain Canyon

RAILROADS that have double-track lines in level parts of the West are comparatively few, but roads that have attempted double-track lines in mountainous districts are still fewer. In most cases the tremendous expense incident to building one track in mountain localities has proved quite sufficient to tax the corporation's resources. While the Union Pacific for many years has maintained a double-track on most of its main line from Omaha to Ogden, here and there, through mountain canyons, the single track has still been the only means of travel both east and west. This summer, however, marks the forging of one of these links, the completion of a second track through the famous Echo Canyon between Emory and Wasatch, Utah. This 16-mile addition to the double-track system cost about $3,000,000, or approximately $200,000 a mile.

Changing a single-track road into a double-track in a mountainous country naturally involves some notable features. In a level country one expects that a second track will parallel the first track, the two being separated by a uniform distance of but a few feet. But in this mountain project the east and west-bound tracks are in one place 2,000 feet apart, seldom indeed on the same level, while in two places the new east-bound track passes underneath the old.

The problem was one not only of building a second track, but of building it so that it would do away with the disadvantages incident to the old line. In the early days of Western railroading a curve here and there did not make material difference. Train loads were comparatively light, and curves and grades often were of secondary importance. The main thing was often to find a location where a road could be built with any success at all. This double-track project illustrates more than anything the passing of the curves and obnoxious grades on modern mountain railroads. The total angular curvature has been cut in two on the second track. On the new track it is 564° 04′, while on the old it is 1,321° 43′. The maximum curve on the new line is but 3° while on the old it was 6°. Likewise a maximum grade of 93 feet to the mile on the old track has been cut down to 60 on the new. Four short tunnels altogether were constructed for the second track. At one point the tunnel for the new track enters the mountain immediately adjacent to the old tunnel, although it is separated from it by 82 feet of rock. Since the grade is east-bound, the new line with the modification of curves and grades naturally will be observed as the east-bound main line, while the old line will be used for west-bound traffic.



The new east-bound tunnel here passes beneath the older bore

The new track is located higher up the slope, avoiding much of the curvature of the old line

A Novel Cable Railway Which Carries Supplies to the French Trenches

ONE of the war's greatest problems is that of supplying the armies at the front. Railroads, it is true, play a large part in the transportation of supplies, but since they can only come to within a few miles of the actual fighting line, the most difficult phase of the problem is encountered in the carrying of supplies from the railheads to the trenches. In most sectors the French forces employ light railways of 60-meter gage (about twenty-four inches) for bridging the gap between the standard railroads and the immediate supply depots at the front. These railroads, using horses or steam or gasoline power, operate in the open in the majority of instances, although in exposed territory they run through tunnels which are given various names such as "Saint Gothard," the "Metro" and the "Simplon" by the witty poilus. Motor trucks and horse-drawn vehicles are used in other sectors where, for some reason or another, the narrow-gage railways are not available.

A rather unusual method of solving the transportation problem at the front has been introduced by a French division operating in a wooded country which does not lend itself readily to the narrow-gage railway. This method, which is the subject of our cover illustration, consists of a light cable railway over which travel light cars provided with grooved wheels, as shown. The cable railway, it will be noted, is erected at the side of the boardwalk, and is supported by the pointed ends of logs arranged in pairs and at regular intervals. Obviously the cars cannot carry any great weight, but since a large number of cars are used the capacity of the novel railroad is ample for the requirements. The particular installation shown in the cover illustration is drawn after a photograph made a short distance in back of first-line trenches.

One would imagine that when the supplies reach the depots immediately to the rear of the trenches the difficulties of military transportation are ended. But this is contrary to fact; for when an army is actively engaged, it becomes necessary to devise ways and means of transporting food and other supplies from the trench depots to the fighting line, particularly when the forces are advancing.

For the trench-depot to fighting-line service the usual practice is to employ men for carrying food and other urgent supplies. These men often must carry their loads under heavy fire, across the most difficult terrain, and despite the rather inglorious, unspectacular nature of their mission, the large toll of death collected from among those engaged in this service proves their task to be one of the most dangerous in a war of almost limitless danger. Many are the reasons given for the successful French defense at the battle of Verdun, but it has been said that one of the main reasons was the work of the "soup brigade" which saw to it that the fighting men were well fed.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

True and False Anti-Submarine Strategy

NOW that the U-boats have transferred their operations to deep water—to the Atlantic—the prospects of finding and destroying them can be proved to be mathematically and progressively hopeless.

Let us suppose that a destroyer can effectively patrol 20 square miles of surface, that is to say, a square measuring approximately four and one-half miles on the side. Let the problem be to patrol the approaches to the English Channel and the Irish Sea. On the chart draw a line, say, from Queenstown to the north coast of Devon. On the westward side of the line describe a semicircle with a five-mile radius. It will contain about forty square miles; and, on the basis of twenty square miles to the destroyer, two boats would form a sufficient patrol.

On the same base line describe a series of semicircles, with radii, successively of ten, fifteen and twenty miles. They would contain 157, 353 and 628 square miles, respectively, and would require for patrol, 8, 18 and 31 destroyers. Use a 50-mile radius and you get 3,927 square miles calling for 196 destroyers. Let the radius be 100 miles, and 15,708 miles must be patroled by 785 destroyers.

Recently the U-boats attacked an American ship 200 miles out from the Channel. An effective patrol covering that distance would require over three thousand destroyers.

To maintain an effective deep-sea patrol against powerful, heavily armed and armored U-boats calls for the large, fast, heavily armored destroyer. Wooden "chasers," "swatters," tugs, yachts and all that multitudinous fleet that did such good service in more or less sheltered waters, are helpless against the far-ranging, ocean-going U-boats of later German design.

So we see that to let the submarines escape to the open and then try to run them down on the trackless wastes of the Atlantic, is to pursue a phantom and fetch up against a *reductio ad absurdum*. The mathematics of the thing is all in favor of the U-boat and against the patrol. Multiply the patrol as we will—the Germans have only to move a few miles farther out from the coasts, and the balance in their favor is restored.

British naval officers were the first to recognize the value of Mahan's works on naval strategy. Therefore, it is puzzling to see them tackling this submarine problem along lines which Mahan would be the first to condemn. Were Mahan alive today, doubtless he would decry this futile submarine chasing, and call for an immediate blockade of the enemy—a close coastal blockade if possible—otherwise a distant blockade.

The close blockade is not possible under modern conditions. To close the German bases with nets, mine-fields, etc., *and maintain these intact*, would call for a patrol of capital ships and this, in view of the enemy submarines, and the proximity to his bases, would spell disaster.

But a distant blockade, formed by placing heavily patroled bomb-curtains at the Straits of Dover and across the North Sea from Scotland to Norway, would entirely reverse the situation by establishing the blockade adjacent to the Allied and remote from the German bases.

A bomb-curtain, 200 feet deep and 250 miles long would be a gigantic work; but it would be well within the resources of modern engineering and seamanship. Moreover this is a gigantic war, and we must learn to multiply our units of measurement by 100.

Great Britain, who raised a volunteer army of 5,000,000 men and equipped it in two years' time, is not going to blanch, surely, at a job of net building and mining—particularly when she realizes, as she must sooner or later, that this is absolutely the only way in which she can crush the U-boat attack.

Work for the Cripple to Do

IT may seem rather premature to make preparation now for cripples that will come back from our fighting ranks in France. Our soldiers have not yet taken up their position on the battle front; in fact, the great army that we are preparing to send over there has not yet been formed. It may even seem indiscreet to talk of maimed soldiers before they have begun to fight. Undoubtedly it is the prevailing opinion that preparations for cripples could safely be deferred until the wounded begin to leave the hospitals. This opinion, however, is based upon a misconception of the seriousness of the problem. In the earlier months of the war, when our allies were faced with the situation of having large numbers of crippled soldiers to provide for, efforts were made to find employment for them which would be adapted to their handicapped condition. The matter was not taken very seriously and the idea first seemed merely one of keeping such men busy. Apparently it was not realized that a full-blooded man does not necessarily loose his manliness with the loss of an arm or a leg, and that one who has been accustomed to a man's job is not likely to be satisfied with anything less than a man-sized task after being maimed. If he feels that the work provided for him serves merely to keep him from idleness and is not a work that will be of real use to the community, it results in a crushing of spirit which is bound to do him harm mentally and morally. For instance, the early French cripples were set to work weaving baskets—a task which is now performed by machines; and even the American Indians who have a world-wide reputation for weaving baskets have not been able to stand up against the competition of the machine. Why then should an inexperienced man, and one who is crippled at that, be given such a class of work? It is not strange that the French crippled soldiers revolted against such trivial labor realizing that it was of no economic importance to the community.

Recently, serious efforts have been made to provide work which would be particularly adapted to the handicapped cripple and which at the same time would be of real value to the public. This has called for a great deal of very careful study. At first men were set to work on machines and were supplied with appliances which would adapt them to the operation of such machines. A more recent consideration of the subject and one which has been developed mainly in this country, has led to the adaptation of the machine to the man rather than the man to the machine. In a recent issue of the SCIENTIFIC AMERICAN we showed how the French cripple has been equipped to operate the typewriter, and also how Americans on the other hand have adapted the typewriter to the crippled soldier.

The subject is by no means a simple one. There are very few men in this country who have given it the attention it deserves. Even abroad where the matter has been in the hands of experts for many months, there is still a great deal to be learned. It is realized now that before a cripple can be trained, a teacher must be provided to train him, and this teacher before he takes up his duties must go through a long course of training himself. It is just as necessary to prepare for the cripples who are to come out of the hospital as for those who are to go into it. As a matter of fact the problem of handling the former is one that requires greater preparation than that of handling the latter. This country is well supplied with physicians and surgeons. We can spare thousands of them at a moment's notice, but there are probably not a dozen men in the entire land who are fitted to take charge of occupational schools for cripples.

One of the most astonishing facts disclosed by a study of the situation is that the arts of peace actually produce more cripples per year than the savage practices of war. It is an economic necessity for a country to make producers out of all its citizens, and while the war has focused our attention on soldiers the task of finding occupations for cripples is just as important in times of peace as in war. A study of what industrial cripples have done under the stress of necessity shows that there is a great deal for the crippled soldier to do. In fact, when the matter is taken up scientifically, it is found that the productive possibilities loom up very large, and the work of crippled soldiers under proper guidance is but a small part of the work that may be done among cripples of all classes.

As we are going to press, the Council of National Defense is meeting to discuss this very problem, and undoubtedly this able body of patriotic men will handle the situation in a truly scientific manner.

There is work for everyone to do no matter how badly injured. A statement to this effect recently made by a careful student of the problem, was challenged by one of the audience who cited the case of a soldier who had been so badly injured that he could move neither hand nor foot. "He was an absolutely helpless cripple. He could not move a muscle. What could you do with such a helpless specimen of humanity?" he cried. "I would make an incubator of him," came the quick response. "If he could not move a muscle he could not crack an egg."

The Engineering Viewpoint

AT all times since 1914 we have seen the very widest divergence of opinion upon all questions connected with the war—its probable duration and outcome, the net results of current campaigns, its internal effects upon the nations engaged, the reactions of internal affairs upon it. Confident souls may always be found prepared to explain in detail just why this side or that is certain to break down next week or next month; and on the other hand we need never look far for opinions placing the conclusion of hostilities five or even ten years in the future, and painting the ultimate outcome in the gloomiest hues. The military experts have the same campaign resulting now in Teutonic occupation of all the Balkans and northern Italy, and now in the crushing of Austria and her detachment from the Kaiser's cause. At times it seems to the layman that everybody is guessing wildly, and that his guess is quite as good as any other.

The reason for such lack of accord among really responsible thinkers is the insufficiency of the data upon which they are willing to express opinions. If a competent engineer be asked what load a certain bridge will bear, and be given all the necessary information, he will provide an answer, and a correct one. If we withhold half the data and falsify the other half, his ability to give satisfactory advice is reduced to a minimum. And this but feebly indicates the maze of uncertainty which must surround anyone who tries to understand what is going on in any theater of the war.

Upon every decision we are called upon to make with regard to the prosecution of the war, upon every question about which general discussion revolves, facts without number, military and naval, economic and industrial, scientific and statistical, about the United States, our Allies and our enemies, have a bearing. And the most we can ever hope for is that we have some of these facts right, some of their mutual relations correctly estimated. We deceive ourselves, our Allies consciously and unconsciously deceive us, the enemy expends money and effort without stint in the vital business of deceiving us.

There are two ways of dealing with such a situation. The most obvious is to refuse to have anything to do with it until adequate data are furnished. At the present time we cannot take this attitude. With defensive war forced upon us, the problems of war must have the attention alike of those of us who are clothed with the responsibility for decision and of those whose views constitute merely a contribution to public opinion. And we can only avoid error in our conclusions by adopting and rigidly adhering to the mental habit of the engineer.

The popular conception pictures this gentleman with a theodolite before him, a slide rule and a bulky volume of formulae in his hands, and a table of logarithms concealed about his person. This is hardly fair. These are the tools of his trade, to be sure, but his horizon is not limited by them. We think of the sculptor and the artist, not as creatures of the chisel and the brush, but rather in terms of that part of themselves which goes into their work. Why not look upon the engineer in the same light?

The engineer's larger function is not one directly connected with his tools at all. He is the man who, of all others, is an expert in cause and effect, in premise and conclusion. What happened, and why? what will happen, and why? these are the questions with which he lives and has his being. This means not merely that he is supremely able to draw conclusions from given data, but that he is equally gifted in the art of testing his premises. We cannot all imitate his skill; but every one of us can borrow his methods.

These consist simply in willingness to make a painstaking search for every scrap of information bearing upon the point at issue, and to look upon every such item in the light of whatever of his present knowledge bears in the least upon it. They consist in recognizing at once whether he can thus shed sufficient illumination upon it to establish its probable value, and if he cannot, in going, without waste of motion, to the place where he can best supplement his knowledge to that end. They consist in eagerness to weigh every scrap of evidence thus obtained separately and against every other scrap, in order to determine their mutual bearings, their relative values, and their logical product, if we may be permitted the use of the somewhat technical term. They consist, finally, in absolute refusal to form any judgment at all until he has passed, to the best of his ability, upon every essential point involved.

We are none of us experts in all the fields involved in the complete discussion of any question brought up by the war, and few of us are experts in any of these fields. Nevertheless, every one of us is capable of getting the engineer's point of view and applying it. If we will all try to do this, if, above all, those of us who are engineers will shoulder a due share of responsibility for spreading the rule of reason, we shall have less circulation of wild rumors, less waste of effort upon impracticable plans, and a generally better understanding of what we are trying to do and why, and how we hope to do it.

Electricity

Electric Prod for Rebellious Cattle.—An electrically charged rod for driving cattle is being introduced upon some of the ranches in western Texas according to recent reports. It is understood that the rod or prod consists of four small dry cells, a step-up induction coil, a push button and suitable electrodes for applying the high tension current to the animal. For driving cattle into dipping vats, branding pens and other enclosures, the electric prod is said to be especially suited.

A New Type of Electric Locomotive.—The Pennsylvania Railroad has completed the construction of a large electric locomotive at its Altoona, Pa., shops for use on the mountain division between Altoona and Conemaugh, a section of road which is now being equipped for electric operation. The locomotive is the first of a number of similar type to be built, according to the *Electrical Review*. The unit measures 76 feet, 6.25 inches, over all, with weight of 240 tons; it is capable of developing a maximum of 4,800 horse-power and has a tractive force of 87,200 pounds, with a speed of from 10.3 to 20.6 miles per hour over the heaviest grades, and can be operated in either direction.

New Thermostatic Metal.—A leading electrical apparatus manufacturer has perfected a new thermostatic metal which is said to take a curve and regain its original straightness in accordance with well defined laws as the temperature rises or falls. As a result of this responsiveness to temperature change and the mechanical force developed, this metal is used to actuate various mechanisms which tend to neutralize either the temperature change or its effect upon devices. The metal consists of two strong non-corrosive metals possessing a wide difference in coefficients of expansion—the widest difference possible for any known stable combination of metals. These two metals are firmly attached to each other throughout their entire length so that there is absolutely no slip of the one metal upon the other. As an indicator this metal is remarkable in that it can be used for temperatures as high as 500 degrees Fahr.

Electrical Daylight for the Back-Yard Garden Workers.—In order to stimulate still further the back-yard garden movement, an electric lighting company of New Orleans has introduced an efficient form of garden light which can be used by those desiring to work their plots after nightfall. Usually the workers must cease their activities after 7 or 8 o'clock in the evening, whereas if they were provided with the proper lighting facilities they could work several hours longer. To this end the company has brought out a long, pointed pole equipped at the top with a lamp and reflector to throw the light downward and provided with an attachment extension cord that can be plugged into an outlet in the house or garage. The pole can be readily stuck into the soft soil of the garden, and the reflector can be adjusted to throw the light in any direction desired. It is understood that several of these outfits are in use in New Orleans, and the idea might well be adopted in other cities and communities.

Electricity Thieves and How They Are Caught.—With every chance in the world that the theft will eventually be discovered, it is a wonder indeed that so many people steal electric current. Yet the practice in the United States is fairly extensive; and of the various methods employed by electric light companies in detecting current theft a most ingenious one consists of connecting the meter in series with a meter in an old transformer case. This concealed meter, states the *Electrical World*, is hung on a pole as close to his premises as possible without the suspected thief becoming aware of what is being done. After the meters have run in series for ten days, a box is put around the meter in his house and locked up; then the meters are allowed to run in series for another week or ten days. With this evidence at hand a company feels that it is sufficiently fortified to insist upon the consumer coming to its office, where he is accused of stealing energy and asked to settle or face legal charges.

Multi-Speed Alternating-Current Motor.—An improved type of multi-speed motor which is said to have a speed range similar to that of direct-current motors has recently been brought out by an American concern. Maximum efficiency is secured over the speed range provided without the expense and complication of auxiliary apparatus, the speed being varied by turning a hand wheel which changes the reluctance of the field magnetic circuit. The motor is furnished in two types, continues the *Electrical World*—bipolar and four-pole. Both are iron-clad and particularly adapted to steel-mill service and for driving heavy machinery as well as printing presses, pumps and other similar equipment. The pole pieces and plungers used to vary the magnetic reluctance are designed so that as the volume of effective magnetism is diminished by the outward movement of the plunger the remaining magnetic flux is forced toward the direction of the pole tips, thus furnishing a magnetic field which, it is said, will insure sparkless commutation.

Science

The British Association for the Advancement of Science, for the first time in its history, will omit the annual meeting this year. Plans had been made to hold a meeting at Bournemouth, but restrictions on travel and lack of accommodations at Bournemouth resulting from war conditions, have made this impracticable. The council and certain committees of the Association will, however, hold sessions in London, July 6th, when plans will be made for the proposed meeting at Cardiff next year.

The Ecological Society of America held its first annual meeting last December in New York, with a scientific program comprising the reading of forty-two papers. Three research committees have been appointed by the society; viz, on climatic conditions, on soil temperature, and on fresh-water fish and fisheries. A soil temperature survey of the United States and Canada is contemplated. Three field trips were carried out by the society last year; one to Dismal Swamp, one to the dunes of Lake Michigan, and one to the Cuyamaca Mountains and the Imperial Valley of California.

The Increase of Arable Land in Egypt, resulting from the great reclamation works in the Nile valley, amounted to 26 per cent, or about 13,000 square miles, between 1898 and 1913, according to an article in *L'Économiste Français*. However, only two-thirds of this new land has yet been brought under cultivation, owing to an increase in the practice of intensive farming, which is also a result of the reclamation works. In 1913 46 per cent of the farm land yielded more than one crop a year. This has been made possible especially by perennial irrigation in place of farming limited to the season of the annual Nile flood.

"Gassing" to Destroy Insects.—A British official named Timmler, stationed in territory that was formerly part of German East Africa, proposes to take a leaf out of the book of European war experience and apply the process of "gassing" to the extermination of the tsetse fly. His plan is either to use a gas destructive to the flies but harmless to man, or to have the operators use gas-masks in case the gas is dangerous to humanity, and he thinks that the monsoon wind of that region would carry the gas across the fly-infested area. *Nature*, in reporting this proposal, expresses skepticism concerning the results, but says that "an experiment would be better than any expression of adverse opinion."

Amundsen's Arctic Expedition.—A bewildering series of contradictory reports have been published concerning the plans of this long-deferred expedition. Amundsen originally started for the Arctic in 1910, but changed his mind and went to the South Pole instead. It was recently announced that the Norwegian Storthing had voted $55,000 toward the expenses of the expedition. Nansen's old ship, the "Fram," which Amundsen used in the Antarctic and in which he expected to make his long drift across the north polar basin has been condemned, and a new ship will perhaps not easily be found. A feature of the expedition will be the use of aeroplanes in reconnaissance work.

Proposed Reforms in South Africa.—The council of the South African Association for the Advancement of Science has adopted the following resolutions: 1. That the metric system of weights and measures be legalized at as early a date as possible for permissive use until the end of the war, and that its use become compulsory and exclusive after such time as may be found practicable. 2. That the Government of the Union of South Africa should coöperate with the other self-governing dominions with regard to the decimalization of coinage. 3. That copies of the foregoing resolutions be sent to his Excellency the governor-general, the prime minister, the minister of trades and industries, the daily press, and the Decimal Association in London.

A Remarkable Exploring Expedition.—On June 24th, 1916, Mr. and Mrs. Scoresby Routledge arrived in their little schooner yacht "Mana," at Southampton, England, the port from which they sailed February 28th, 1913, on their expedition to Easter Island. The total voyage of about 100,000 miles was the longest ever made by a yacht under canvas. Besides much incidental exploring elsewhere, the Routledge party spent more than sixteen months on Easter Island, in the South Pacific, and brought back a large amount of interesting archeological, ethnological and geological information concerning that much-discussed spot. One interesting discovery was that the numerous stone images strewn about the interior of the island, which have heretofore been supposed to have been abandoned in their present locations while being transported from the quarries to the well-known platforms or terraces along the coast, were actually arranged along former roadways and were evidently intended to remain where they are now found. Much information was obtained concerning a former ceremony of obtaining annually the first-laid egg of a certain migratory bird. Symbols connected with this ceremony are found in abundance on the island.

Invention

Rifle Sights that can be Used at Night are the subject of a United States patent recently granted Britannio Solaro del Borgo of Paris, France. These sights consist of small chambers containing radio-active material whose glow can be seen by the marksman. The chambers are provided with lenses to protect their contents. These special night sights are arranged on a rifle in the usual manner—back-sights and fore-sights—and the marksman simply lines up the faint spots of light with the target. Two chambers or lights are provided for the fore-sights and two for the back-sights.

Matches with the Pipe.—The proper place for matches, believes Alexander Van Buren of East Quogue, N. Y., is with the pipe, for one is not complete without the other. And in accordance with his belief Mr. Van Buren has devised a pipe which has a stem with an enlarged portion below its smoke passage, this enlarged portion having a transverse slot which offers storage space for matches. The slot may be closed by means of a pivoted door or lid member, the outside of which is corrugated so as to afford a convenient surface for striking the matches. Mr. Van Buren's invention threatens to make extinct the timeworn plea of the pipe smoker—"Have you a match?"

Doing Away with the Bulky Motion-Picture Tripod.—By taking the oscillating movement incident to turning the crank away from the motion-picture camera, Arthur R. Selden of Rochester, N. Y., plans to do away with the usual tripod which is both cumbersome and heavy. Mr. Selden makes use of a simple tripod of light weight on which the camera is freely mounted so that it can be swung vertically and horizontally to direct the lens on any object. This feature is especially suited to the filming of moving objects, where the conventional tilting and panorama head movement is too slow. The cranking is accomplished by making use of a driving member supported independently of the camera—on the operator's belt, for instance—and operating the camera mechanism through a flexible shaft.

A Semaphore Instructor.—In these days of great military activity when almost everyone liable to be called for military service is turning his attention to manuals on the different branches of soldiering, the semaphore instructor invented by Joseph E. Meyers of Camp Stotsensburg, Pamponga, Philippine Islands, is of considerable interest. The instructor consists of a screen in which are flag openings located in the different flag positions, and in the center of the screen there is printed a figure representing a soldier. Behind the screen is a disk which has the letters of the alphabet marked on it, as well as color sectors marked in such a way as to be exhibited behind the proper flag openings when the disk is brought to a position corresponding to the letter intended to be represented.

Preventing the Taking of Two Pictures on the Same Film.—A prolific source of failure in amateur photography can be laid to not turning the film after an exposure has been made, with the result that two images are impressed on the same film surface. Even the most thoughtful person is apt to forget to turn the film, and at times invaluable pictures are thus ruined. With a view to eliminating all possibility of double exposure, Clarence A. Hoyt of Tacoma, Wash., has invented an ingenious little device which prevents a picture from being snapped until the film has been turned. When adapted to the box type of camera a catch locks with the shutter-release lever after an exposure is made, and in order to unlock the lever it is necessary first to turn the film. It is also possible to make the device indicate whether the film surface in position has been exposed or not by means of a window in which appears the word "Exposed" or "Unexposed," as the case may be.

A Weapon for Trench Warfare.—It is now well known to all who have carefully followed the progress of the great war that the rifle is not an efficient weapon for hand-to-hand fighting in the trenches, and for this reason particular interest attaches to the invention of Charles J. Cooke of Hong Kong, China, because of its immediate military possibilities. Mr. Cooke's invention consists of a hollow handle two feet in length or more, which is a veritable magazine for firearm ammunition, and an automatic pistol which is attached to one end and a bayonet attached to the other end. The pistol is so mounted that its magazine is in common with that of the long handle; that is to say, ammunition may be fed from the long handle into the pistol so as greatly to increase the ammunition capacity of the automatic pistol. Obviously, such a weapon should be formidable in close fighting for the reason that twenty, thirty or perhaps more rounds can be fired without reloading; indeed, the automatic pistol becomes a veritable machine gun. On the other hand, the bayonet, mounted on the long handle, is as convenient as if it were held on a rifle.

German colonel's subterranean quarters in northern France. This is near the exit of a large cave in which the men are housed

German soldiers living underground in chalk caves on the French front. This particular cave was large enough to house 30,000 men

Exploring the Burrows of the German Army

Elaborate and Well Furnished Subterranean Dwellings

THE accompanying sketches of captured German underground labyrinths give some idea of the very elaborate manner in which they are constructed and the care with which they are fitted up. The survey of this labyrinth was made by the Germans themselves and fell into British hands when the position was captured.

The following is quoted from a letter written home by a British officer, comparing German front line trenches with their own.

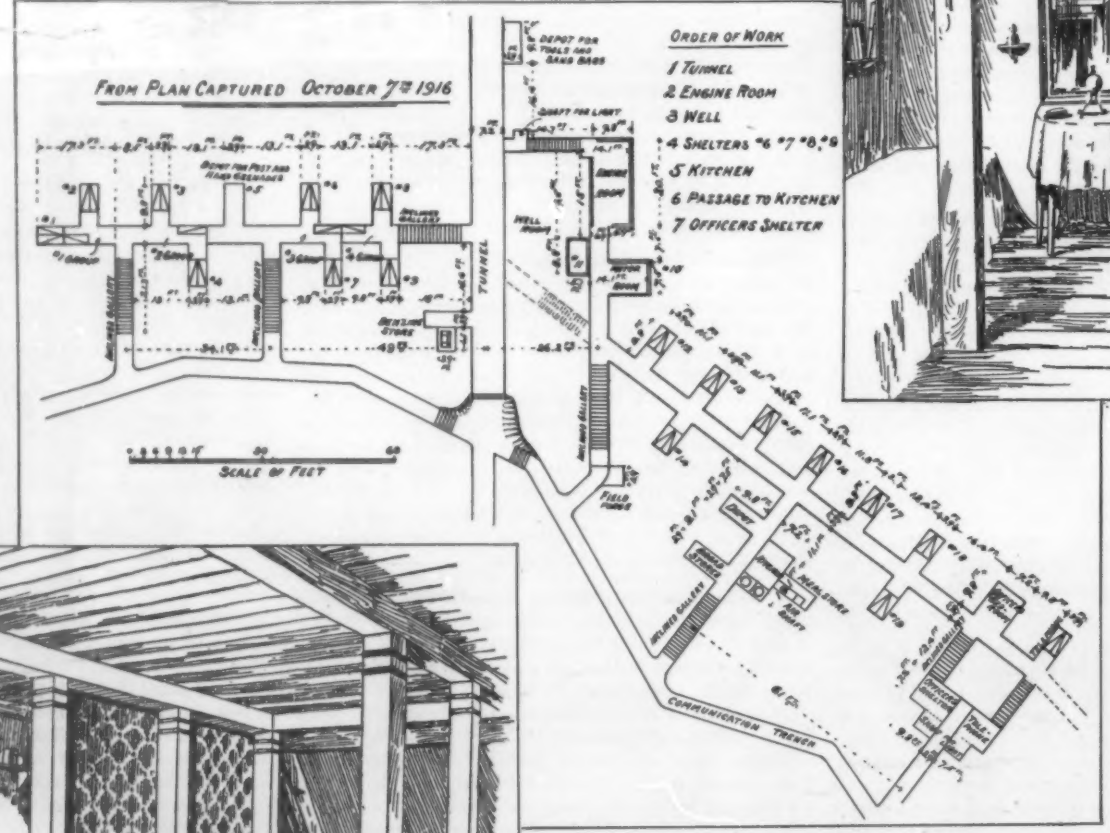
"In standing in the middle of what was a few weeks ago No Man's Land and comparing the German front line trenches with our own, we notice first the more permanent character of their barbed wire entanglements. While ours are supported on wooden stakes of whatever size and shape is found at hand, theirs is supported by iron rods made for that purpose and of the best possible design. Inside the two trenches the differences are still greater. The Allies' trenches look in every way as if they were made by men who hoped and expected to move on before long. The German trenches look like the work of men who expected to remain in this position for years.

"Our trench housing has been more of a makeshift, a sort of camping out, with some ingenious provisions for shelter and comfort, but not more than the least that would serve. Most of our dugouts are just roughly delved holes in the earth with only enough props and rafters to hold the roof up, while the floors are bare ground with a little straw; their doors, if they have any, are a few odd pieces of plank with a couple of other pieces nailed across. We usually have the floor on the trench level to save burrowing. Lighting is done with candles, mostly bought out of our own pocket at the canteen, and if anyone owns an arm-chair or a mirror it is the jest of the platoon.

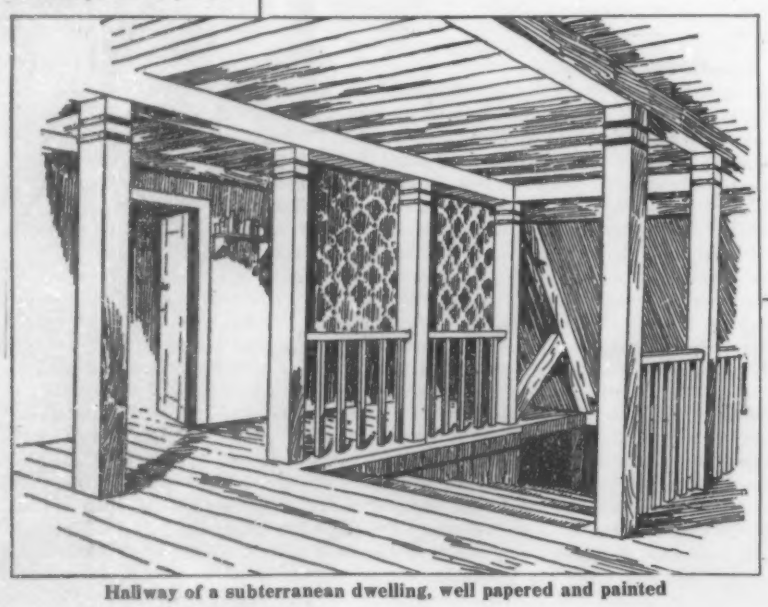
"The German front in the west is like one huge straggling village strung out along a single street of 300 miles. Of course the houses are all underground, still they are houses usually of one or two floors built to certain official designs which are drawn out in section and plan. The main entrance from the trench level is had through a steel door of a standard pattern, so that hundreds may come from a factory on one order and missing parts be easily replaced. The profusely timbered doorway is made to their measure. Outside this front door you will find a perforated sheet of metal to act as a doormat or scraper. Inside a flight of 12 to 36 steps leads down at an easy angle. The treads of the stairs and the roof of the staircase are formed by mining frames of stout timber with double top sills. The walls are of thick planks notched at top and bottom to fit the frames, and strengthened with tie rods running from top to bottom of the stairs and heavy wooden struts at right angles to these.

"At the foot of the stairs a tunneled corridor runs straight forward for anything up to 50 yards and from it open minor passages and rooms on each side. In many dugouts a second staircase or two may lead to lower floors 30 or 40 feet below the trench level, as shown in the accompanying illustration. All these staircases, passages and rooms are, in the better specimens, completely lined with wood, and as fully strengthened and supported as the entrance staircase already described. In one typical dugout each section of a platoon has its allotted place for messing and sleeping, its own place for parade in a passage and its own emergency exit to the trenches. In another, used as a dressing station, there are beds for 32 patients and a fair-sized operating room. A third near Mametz was designed to house a whole company of 300 men with the necessary kitchens, provision and munition store rooms; a well, a machine shop and forge, engine-room and motor-room. Many of the captured German dugouts are thus lighted with electricity.

Sketch of German officer's bedroom



Copy of a German plan of underground quarters



Hallway of a subterranean dwelling, well papered and painted

"In the officers' quarters we found full length mirrors, comfortable bedsteads, cushioned arm-chairs, pictures and books. One room was lined with glazed "sanitary" wall paper and the present English occupant is convinced by circumstantial evidence that his predecessor lived there with his wife and child. Clearly, there was no expectation of an early move. . . .

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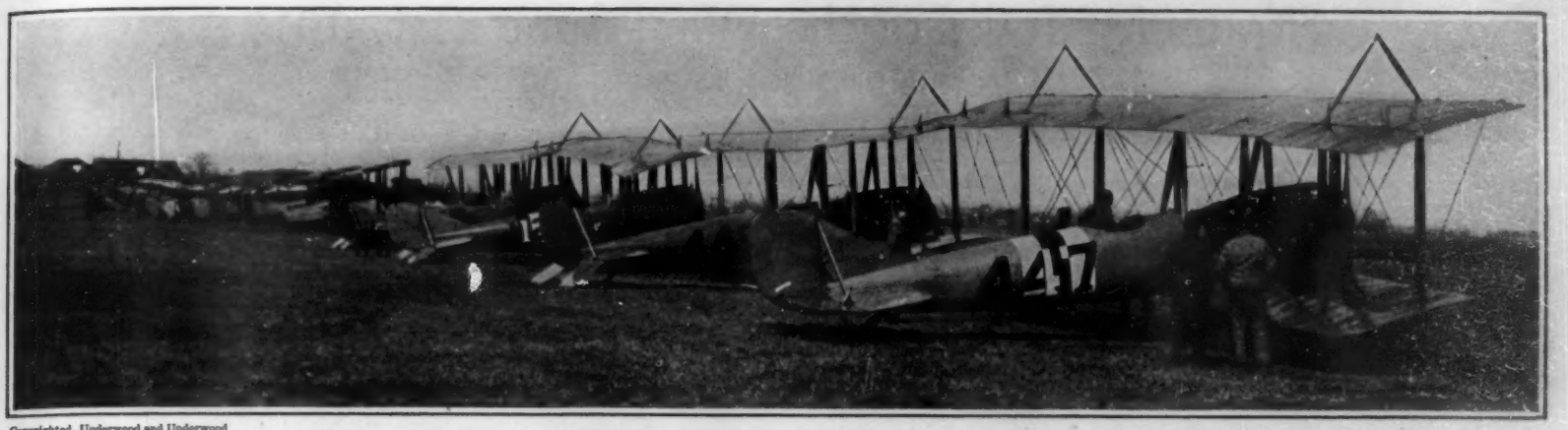

Twenty-five U. S. Army aeroplanes lined up prior to a practice reconnaissance flight at the Mineola, Long Island, aviation school

American Supremacy of the Air

The Problem of the Air Craft Production Board

By C. H. Claudy

IF a monarchial form of government has any advantage over a democracy, its ability to drive over criticism, in place of around it, is certainly the greatest. Public opinion is the underlying moving force in any democracy and before almost any sweeping change in public policy is carried through it must first be demanded by the body politic. The bigger Navy program which followed the Spanish war and the Panama Canal are instances—the storm of criticism which greeted the purchase of Alaska, and the inability of a minority to get an adequate public road program in the United States are negative arguments for the same proposition.

Hence, the plans of the Air Craft Production Board must undoubtedly run a gauntlet of severe public opinion, before they are adopted in full by the National Legislature, and this, despite the fact that the best engineering and military brains of two continents have not only decided but demonstrated that the winning of the war is not in either land force or submarine, but in the air.

It is generally estimated that one competent aviator, mounting a first-class observation or battle plane, is worth, in a military sense, at least 1,000 men on the ground.

The United States can send one, two, three, hundred thousand, perhaps half a million men to Europe within a year. According to this estimate sending 1,000 aviators and 1,000 battle planes in the same time would be twice as effective a piece of work. And if we should send 100,000 aeroplanes and aviators to Europe, the winning of the great conflict would be only a matter of a short time.

This is not a matter of opinion, but of fact. Modern artillery is of little value without eyes. The old field artillery practice, as exemplified, for instance, at Gettysburg, contemplated an enemy one could see, at short range, where hits could be observed and ranges obtained by direct observation with field glasses. When two armies are "dug in" opposite each other, only observation from above successfully directs artillery fire.

Hence, the struggle for the supremacy of the air in Europe is being fought out behind the lines with the same bull-dog tenacity as is the actual struggle. England and France are straining every effort to make their production reach 4,000 planes a month, battle, observation and training. Germany is currently reported and believed already to have reached that production, and she started with a force far superior to either of her principal opponents.

Note that this struggle is behind the lines—in the factories and the workshops. Current reports from pro-German sources to the contrary notwithstanding, neither England nor France need men in the trenches with anything like the imperativeness with which they need workers in the machine shops. Employing women—and with great satisfaction in many cases—wherever a woman can do the work man has done, the factories of England and France have been robbed of many of their skilled artisans. But unless with long training, women do not make good aeroplane builders. If they did—if money were the only thing in the way—the Entente would have discounted Germany's airmen by four to her one long ago.

The popular conception of the use of an aeroplane in modern fighting is of a birdman who makes a sudden dash with a fuselage full of bombs, which he scatters, and darts home again. Spectacular, sometimes useful, such practices are a mere incident in the real work of aeroplanes in war. The real functions of aeroplanes are to carry observers, to direct artillery fire, to discover enemy movements, to photograph enemy positions, to wireless down information.

But to accomplish these ends the battle plane is a necessity; the swift flyer whose business it is to protect the otherwise helpless observation planes from enemy attack, to frustrate bomb dropping expeditions, and to demolish enemy plans of every character whenever possible.

With a full knowledge of the great mass of information which this slightest of sketches suggests—knowledge obtained from such men as Major. L. W. B. Rees, Royal Flying Corps, V. C., D. S. O.—who has been indefinitely assigned to the U. S. Government to aid in its aeroplane and air service development—the Air Craft Production Board of the Council of National Defense has made its plans, collected its data, marshalled its factories, scientists, mechanics and planned training forces, and is ready to go ahead with the most stupendous aero program ever conceived.

It is not the right time to anticipate any bills which may be introduced in Congress looking to the taking of the one big step which America can take *now*—not next year or the year after, but in the immediate present—to end the war. Sufficient to say that this year's army aeronautical appropriation is $60,000,000—*England's appropriation for the same period is almost six hundred millions.* But if one can not anticipate a proposed bill, one can indicate its need.

The average life of an aeroplane on the battle front is less than two months. Not necessarily because shot down, but because of damage done in landing, of wear and tear, of accident incident to this most strenuous of lives. This means a plane mortality of over twenty-four thousand aeros a year, for the Allies. Add a fourth as many more for the essential training planes used behind

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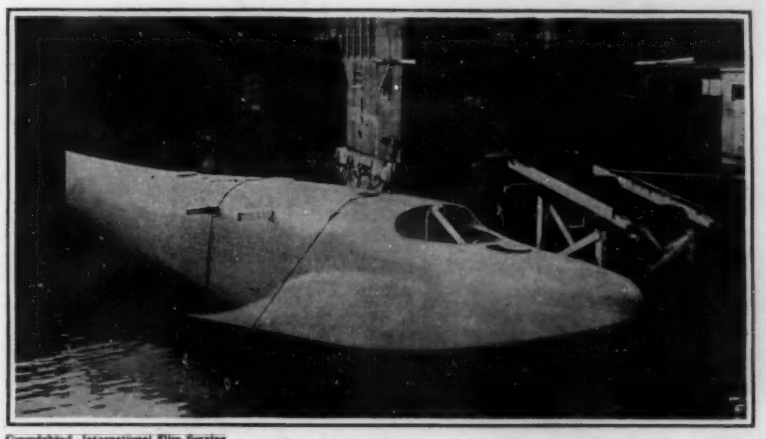
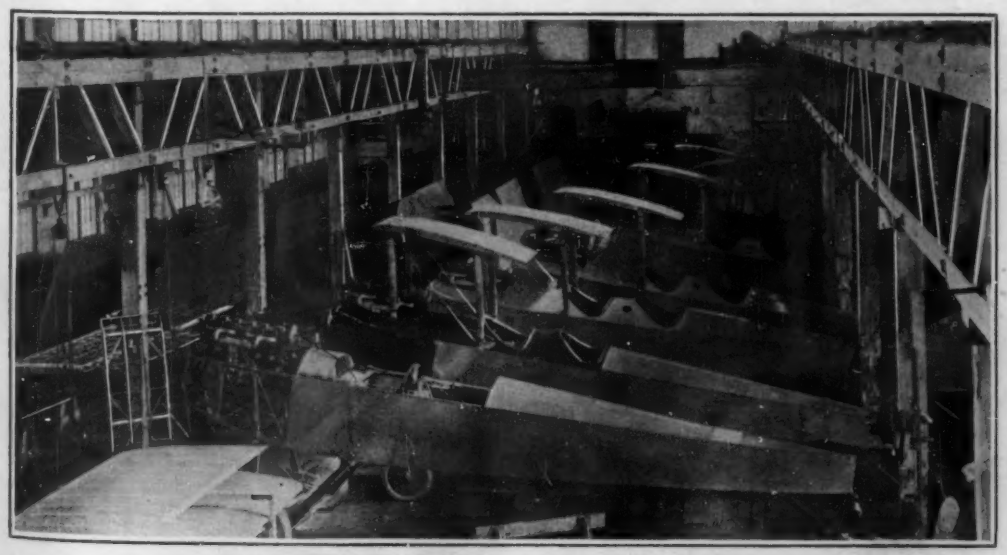


Launching the body of a giant flying boat constructed in America for the British government



The assembly department of a typical American aircraft factory of the present time

U. S. Army aeroplane dismantled for transportation

Strategic Moves of the War—June 21st, 1917

By Our Military Expert

THE one great problem that is now most disturbing the Allies' cause, and particularly to the United States now that our country has entered the war financially as the creditor nation to all the others, as well as an armed participant—is the present and future attitude of Russia, the unformed and apparently uncontrollable giant of the north. The revolution resulting in the deposition of the Czar Nicholas came as a surprise to many, but in reality was in no way unexpected by those well informed. It was only the end of what has been in process of formation for the past twelve or fifteen years. The first chapter was the outbreak of 1905 after the Japanese war, resulting finally in the first Duma or representative assembly. This Duma was dissolved in view of its demands, although these were quite moderate in comparison with what has since been granted or assumed. Following these happenings with varying success, the popular movement culminated when it became evident in the present war that the Czar's government was either incapable of governing or defending the country or was in secret alliance with the Central Powers. When it became evident that Russian defeat was inevitable, the Russian people took the government into its own hands and with this also it took the fate of the country. But conditions, so far as law and order are concerned, have shown little or no ability on the part of the leaders to cope with present surroundings, although latest happenings seem to indicate that one or more strong men have come to the front to direct affairs.

It goes without saying that Germany and Austria have done their best to confuse the issues of the situation by offers of a separate peace or of a separate armistice with a view to separate peace negotiations. These offers have been denounced by the ruling councils but still little or nothing has been done in the way of armed assistance to the Allies upon the Eastern front. This condition became so marked that the President of the United States recently sent a note to Russia calling attention to the anomalous situation. And now the other Allied Powers are calling or will call upon Russia for her to define her intentions and this for her own good. She must be brought face to face with those who would upbuild and with those who would pull down. As in all such critical situations, a number of dreamers in socialism and in other political needs have come forward and are endeavoring to advance radical views of government, its limitations, and uses. But the clearer minds are gaining control as it is seen that anarchy and those who encourage it must be subdued; that argument must give place to action and that discussion must end. Several of the Entente Allies are taking the same view and are demanding that Russia shall fight. In other words, that she must eliminate Teutonic intrigues and must release herself from a situation dangerous to herself and to her Allies as well as to the liberties of all. What the Allies are now forced to impress upon Russia is that there is no longer anything to discuss and that the government must act.

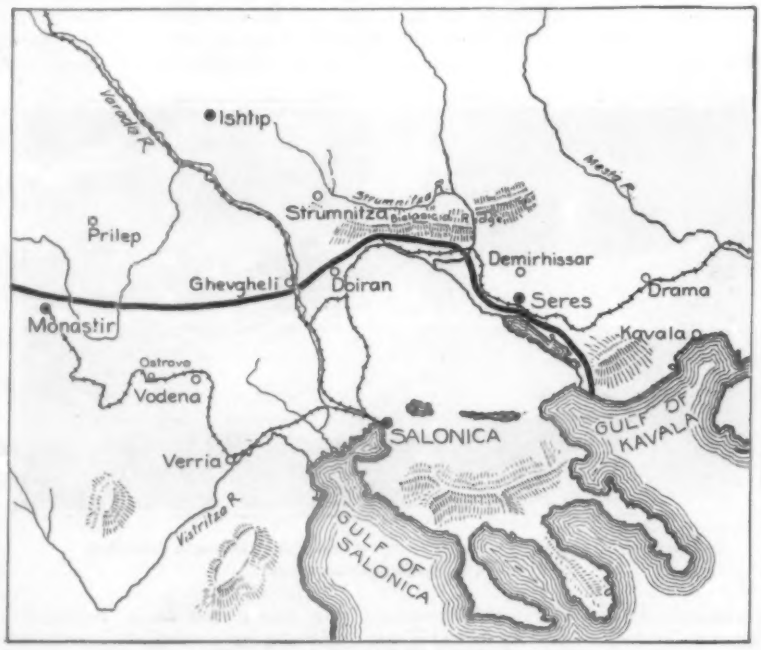
It may possibly be due to this urging that reference has recently been made to lively fighting at several points of the Russian front—notably around Tarnopol and the railway lines leading from it. This is in general along the wedge driven into the Austrian lines last year by General Brussiloff. From all that can be learned the Russian armies in this vicinity are in the best condition of all as regards equipment and discipline. Whether much can be expected or accomplished at other points on the front only time can tell.

An entirely new scene of hostility has been brought on the stage by the capture of Fort Saliff, a Turkish military post on the Red Sea about 175 miles north of Aden at the entrance to the Red Sea. It was captured after a three hours' battle in a naval engagement and is the first land fortification that has been reduced in this war by unsupported naval forces. This undertaking is a possible preliminary to a campaign to clear out the Turkish troops in this part of the Arabian peninsula; these forces have been operating in the vicinity of Aden and also along the approaches to the Sues Canal. The establishment of the new kingdom of Mecca with the ruler's authority to govern in his own right was undoubtedly a blow in the same direction by France and England; this new kingdom includes nearly the whole of the peninsula. This is all in the line of the establishment of a great self-contained British Empire which, beginning with the recent acquisition and conquests in Africa, will be united with India through Arabia and parts of southern Persia. Events have also moved rapidly in Greece, where the abdication of King Constantine in favor of his second son, his departure with his family and entourage on an Allied warship, and the landing of Allied troops at the Piraeus, have followed one another in quick succession. The occupation of Thessaly by French soldiers has been followed by some disorders but it is believed no serious military difficulties will be encountered. If this abdication had been forced two years ago, both Serbia and Montenegro might have been saved and perhaps Rumania could also have been rescued from her present fate. The Allied Powers have and have had powerful armies in Macedonia; but these could not be pushed forward without increasing the danger of an attack from the rear by Constantine's army. The Allied armies were always held back by some mysterious means and it is now believed that Czar Nicholas was that power. The fall of the Greek king is the direct result of the Russian revolution for the Czar was no longer at hand to save him. The Allies are at last in a position to carry on war in the Balkans—a power they could not exercise heretofore.

The strategic plan by which the Greek king's military power was paralyzed was a master stroke; for although his 200,000 well-trained men had been transferred to the Peloponnesus they were still in a position to fall on the Allies' rear if any advance to the north of Saloniki were attempted. The Greek king had made all arrangements for moving his troops by transports across the Gulf of Corinth or over the narrow isthmus, into Athens and thence into Thessaly; the latter is called the granary of Greece. Here his troops could have been easily supported in a country rough, broken, and well suited to warfare. In Thessaly he could have threatened the entire Allied line from any point north of Saloniki all the way across to Monastir, Lake Presba and through Albania to Avlona on the Adriatic. But to thwart this scheme the Allied fleet was brought into the Gulf of Aegina from the east so that its guns commanded the narrow Corinthian isthmus; to prevent any transportation of troops across the Gulf of Corinth, the Allied warships and transports entered the Gulf and took possession of Itea on the north side at the head of Salona Bay. This completely checkmated any plans for movements across the Gulf and the 200,000 men of the Greek army were "bottled up" in the Peloponnesus.

The latest reports indicate that the Allies hold Piraeus, the port of Athens, as well as the heights around Phalerum Bay and that they are also marching upon Athens itself. One great result of the Allied control over Greece will be the prevention of the use of the Greek coast and neighboring islands as U-boat bases; already the Allies have protested strongly against this and now drastic measures will no doubt be taken to stop this German violation of the nominal Greek neutrality. Most of the sinkings by submarine boats in recent months have been attributed to boats operating from bases in the Greek islands around the mainland coast and it has been generally known to the Allies that the Germans were violating the neutrality of Greece by the use of her territory for hostile purposes.

Earlier in the war, U-boat bases were found on the coasts of Africa and were destroyed but greater difficulties were experienced in locating them in Greece. The danger was so great that new routes for supplies and troops for the Allied armies in the Balkans had to be employed in order to avoid the Aegean Sea. Under the new status now established all this will no longer be necessary.



Theater of operations in Macedonia

On the British front in Belgium a partial German retreat appears to be in operation though it is not distinctly so stated as yet in official reports. Mention only is made that an advance east of Messines had compelled the abandonment of sections of the first lines of defense between St. Yves and the River Lys and extending as far north as Kleine Zillebeke. The German forces within the triangle having its apex at Comines with one side along the River Lys, another along the Ypres-Comines Canal and the base extending along the line Kleine Zillebeke, Messines, Capard, Warneton, are in a position that must be most disturbing for them, as the commanding ground to the west is held by the British, while at their rear is a river on one side and a canal on the other to be crossed in case of a retreat. The advance of the British forces mentioned above may necessitate only a local withdrawal for a time but the strategic importance of the capture of the Wytschaete-Messines ridge cannot be overestimated and its value will be shown in future developments. Telegraphic despatches state that the German heavy shell are falling generally at extreme range which would indicate that the enemy has withdrawn his heavy guns as far to the rear as possible without putting them entirely out of action. The country across which the Germans are retiring is low and in rainy weather is entirely flooded and marshy. Due to the long continued drought, however, this ground offers no difficulties in crossing and British patrols are following close on the heels of the enemy. Under such conditions the strategic possibilities are certainly interesting. So far the Germans have gone back to a line running due north from Warneton, thus flattening the Wytschaete salient that has been occupied by them since 1914. But it now looks as if both Warneton and Comines must be soon evacuated. In that case, the retirement cannot stop until the southeast bank of the Lys River has been reached for there is no observation point nor even a village in the angle between that river and the Ypres-Comines Canal where new lines can be established. Between Armentières and Menin the Lys River forms the boundary between Belgium and France; beyond the latter town it flows through Belgium till it joins the Scheldt at Ghent. The English commander could therefore well choose the river valley for an approach into Belgium just as he is using the valley of the Scarpe for the capture of Douai.

As regards the present strategic position on this part of the front, it can be summed up as follows: one military road or highway leads from Armentières into Belgium along the valley of the Lys. Another road passes through Ypres and running southeast joins the Armentières road at Menin, an important railroad and road center. The Wytschaete ridge is in the angle between the two roads and commands the entire position. This explains why the Germans placed such importance upon it and fought so hard for its possession. Having so strongly fortified it they believed it was practically impregnable and that an entrance into Belgium was barred so long as it was held. In addition, with La Bassee strongly held, it formed a strong support for the German right wing; this gained in importance as everything depended on the security of this wing to hold Belgium since without Belgium the German campaign could not go on. Now that this support is lost, it remains to be seen how long the Germans can hold on without endangering the defense all the way from Armentières to Dixmude and beyond. Reports of fighting in the vicinity of Monchy and the Scarpe River valley continue to come to hand. This is the case farther south around Bullecourt also.

The British are driving slowly but surely on Douai, Lille and the great industrial region around it that includes such towns as Tourcoing and Roubaix. That even greater objects may be in view, a study of the strategy of the various moves on this part of the Western front would lead one to believe. There seems to be no danger of a German counter offensive of any great extent on the British front for they are apparently lacking in men and materials, and especially in artillery. If reports of German prisoners can be believed many of the

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Recent Chemical Developments

Grinding Wheels

By Ellwood Hendrick

THE modern grinding wheel and grinding machine constitute what Mr. Richard G. Williams of Worcester, Mass., calls the necessary link between the electric furnace and the automobile. They are needed for accuracy in producing crankshafts, pistons, piston rings and pins, cam shafts, eccentric rods, steering knuckles, rear axle housings, roller bearings, ball bearings and a whole list of other features in making motor cars alone. And in one way or another they come into use in the production of things of all kinds from safety razors up to steel shears. At the Detroit meeting of the American Electrochemical Society, Mr. Williams read a paper on "The Grinding Wheel," which was lately published in *Metallurgical & Chemical Engineering*. In this paper the processes of making artificial abrasives and grinding wheels are outlined at length. The old-fashioned grindstone in the tool-house in the barn, reminiscent to many of us of some of boyhood's unhappiest hours, is referred to, but it is not the subject of his discourse. Neither do emery nor natural corundum wheels meet the requirements of the present day. Diamond dust is not recommended for reasons that require no guessing to discover. The two leading materials are a straight chemical combination of carbon and silicon and a kind of glorified corundum or emery—for emery is an impure corundum.

To make the first type, which is an aluminous body and, in effect, an oxide of aluminium, the raw material is either bauxite or emery. The furnace consists of a wrought iron shell or some form of pot lined with carbon. The electrodes are suspended in the pot, lowered to the bottom of the furnace and a train of graphite or fine coke leads from one pole to the other. Then "suitable chemicals" are mixed with the charge, the details of which are not given, but their purpose is to remove such materials as iron and silicon. Before the charge is prepared, however, the bauxite is calcined to drive off 30 per cent of combined water. The furnaces have a capacity of three tons and when the charge is made the current is turned on. This requires from 650 to 700 horsepower and a furnace run takes about twenty-four hours. Then the thing has happened. The content of the furnace is still an oxide of aluminium but it has undergone a marked change. The water is out of it, it has taken on an amorphous instead of a crystalline form and it has achieved a scratching power that might well defy any army of amazons or drive all the cats of Kilkenny over the back fence. When cooled it is a fused mass and this is broken up by hammers into convenient pieces and sent to the jaw crusher.

The carbide of silicon type is prepared in a resistance furnace. The raw materials are coke, sand, sawdust and a little salt to extract the carbon from the coke and to tie up the silicon from the sand to the carbon, atom for atom. The heat is radiated and conducted from the central core of finely ground carbon. The process takes about thirty-six hours for a furnace run and about one thousand horsepower is consumed. After the run this material is also broken up.

The next step in both processes is the preparation of an abrasive grain. The lumps go first through manganese steel jaw crushers and then through successive rolls until sizes as fine as desired are obtained. Some abrasives contain magnetic material which is removed by a magnetic separator. Then it is washed to rid it of dust and particles that are too fine, then dried and separated into different sizes for different purposes by means of screens. Still nicer separation is obtained by what are called hydraulic classifiers. These are based upon the principle that the material to be separated according to the size of its particles is introduced into water moving with a definite velocity. The velocity is sufficient to carry away the finer particles while the rest is heavy enough to remain in the original container.

Grinding wheels are composed of two main constituents: the abrasive and the bond. The bond holds the particles of the abrasive together, and different bonds are used for different purposes. So-called vitrified wheels are made of the abrasive mixed with clay and water according to definite, secret recipes. The materials are thoroughly stirred up in a mixing apparatus, molded into wheels and dried. Then they are "shaved" or turned into the dimensions and shapes desired, and fired.

Another variety of vitrified wheels are made by what is called the pressed process. Here much less water is used and the clay and abrasive are kneaded in kneading machines until the proper consistency is reached. The mass is then molded into wheels under great hydraulic pressure. These do not need shaving. The next operation is heat treatment in kilns. A moment's reflection will make the nature of the vitrified wheels a little more familiar to us: the grains of the abrasive are held together in the form of a wheel by what amounts to a vitrified brick.

Another kind is silicate wheels in which silicate of soda (water glass) and other chemicals which Mr. Williams does not mention, are mixed with the abrasive, and molded and heated. It is said that the molding "is an operation into which the personal equation enters to a large extent." Evidently it is tricky, and the successive steps of the reaction are not thoroughly known. It would appear that the silicate wheels are those made of grains of the abrasive, held together by a kind of glass as a binder.

Elastic wheels are needed for some purposes and the main constituent of the bond in these is shellac, which is mixed with the abrasive grains and other bodies, including doubtless a solvent to cut the shellac. The whole is mixed and kneaded and allowed to cool to a brittle cake. The cake is broken and put into iron molds, and then heated and pressed.

Vulcanized wheels are those in which the bonding is done with crude rubber and sulphur, mixed with the abrasive. It is then pressed into molds and heated. The final operations with all wheels are truing and bushing, then testing, after which they get one more inspection before they are packed and shipped.

These grinding wheels have fine work to do. Limits of irregularity as low as 0.0005 inches and 0.00024 inches are often given. And it should be remembered that when 0.00025 of an inch is being ground, the heavy slide that carries the wheel and wheel spindles moves forward only half that distance. If a piece of tissue paper were split 12 times consecutively, it would have the thickness under which these machines have constantly to work. And yet, when we consider the forces present in a wheel weighing 200 pounds rotating at a speed of 1,200 revolutions per minute, we are not reminded of a watchmaker's lathe, despite the exquisite precision of the operation.

"The next time you take a look at the engine and transmission machinery of your car," says Mr. Williams, "pray do so with a certain kind of reverence, and take a few minutes from your busy life to reflect that the product of the electric furnace has made all this possible."

What I Can Do for My Country

VI. The Civil Engineer

THE civil engineer stands out in sharp contrast to the other citizens of the technical community by virtue of the fact that when he has finished a job he is through with it. He does not, like the mechanical engineer and the electrical engineer, construct machines for the maintenance and repair of which he is perpetually responsible; he does not, like the chemist and the mining engineer, devise processes which require his constant supervision. Rather, as we have remarked in a previous article, the whole theme of his work is that his creations are fixed and immutable, defying the ravages of time, the elements, and the specific forces which they are designed to withstand. Consequently, once they are completed, they demand no more of his attention and pass automatically out of his life. The civil engineer builds skyscrapers, bridges, railroads, docks, dams, tunnels, highways. When he has put the final touches upon one of these achievements, he is through with it; he goes away and leaves it, to attack a fresh problem in the next street, the next state, or the next hemisphere.

Accordingly the plunging of the nation into a state of war brings to the civil engineer a much less complex problem than to any other technical man. The war-time intensification of all industries means little to him; in fact, war tends to contract rather than to expand the call for his services. The crucial problems of production on a war basis are those of labor, material and transportation. Except in the few cases where he is called in to assist in a big new power development, these items concern him not in the least. Indeed, as the iron and steel output is more and more absorbed by the building of ships and the making of munitions, as the transportation facilities of the country are more and more given over to the moving of food and necessities of war, even the ordinary work of the civil engineer shrinks to an irreducible minimum. Only those building projects, those railroad betterments, those hydro-electric undertakings, and those highway developments are prosecuted which cannot by any means be deferred. In general, when war comes the civil engineer finds himself out of a job.

If the other fifty-seven varieties of engineers are to be persuaded to refrain from enlisting because of the abnormally great demands for their services in the essential industries, the civil engineer might logically be urged to enlist merely on the ground that there does not seem to be much else that he can do to help push the war. When to this argument we add the one that our army and the armies of our allies are in desperate need of all the engineering talent they can get, the logic becomes compelling. Unless he happens to be one of the very few whose talents are being turned to the industrial prosecution of the war, every civil engineer can by all means do his best for the country by volunteering for army engineering service, in France or elsewhere.

It may not be out of place to say a word or two to indicate why this emergency is so great. Obviously enough, in the transportation of supplies and the movement of men on such a scale as called for in modern warfare, special railroad and highway construction is demanded. Obviously, too, bridges must be built, trench systems and mining operations carried out, and the landscape in general changed to meet the military requirements of the situation. But this is not the worst. The civil engineer ordinarily builds for all time, as we have remarked; but when he is opposed by an altogether uncivil set of engineers whose sole mission in life is to destroy his work as fast as it is completed, and if possible faster, his task is a never ending one. He cannot build and go away, as is his custom; he must build the same thing over and over again, as fast as the enemy destroys it; he must be on the spot every minute of the time prepared to make a fresh start at the bottom of a bottomless abyss into which his fairest creations have been suddenly transformed. And if by combined good luck and good judgment he builds so well that the artillery and infantry using his roads and bridges and trenches are able to drive the enemy so far away that these structures are safe from hostile fire, he must at once put forth redoubled efforts to build new trenches and new roads and new ammunition shelters five miles farther forward, so that the dear enemy may still have something to shoot at. Moreover, it is contrary neither to the rules of the game nor to the laws of probability that the civil engineer will himself get shot up every now and then; and there must be enough of him so that this unfortunate circumstance will in no manner interrupt his work. So the civil engineer need hesitate no more to volunteer for the engineering corps through fear that his work therein will lack the savor and the excitement of actual battle than through feeling that his field services are not necessary to win the war.

Nor should we emphasize the importance of battle-line engineering at the expense of the engineering which is necessary in order to get men and supplies to the line of battle. The railroads of France and Germany have been put to a terrific strain for the past three years. If you have ever built a railroad, ask yourself what it would look like after operation for three years, at many times its proper capacity, with no inspection to speak of and only the most casual work of maintenance and repair. The inability of Germany to stop the nut-cracker advance of the British is due quite as much to the fact that the German railroads are being literally patched up from day to day to make them hold together as it is to any actual outstripping of the German industrial pace by the British. It is among the possibilities that the French attack suffers more or less general breakdown this summer from the same cause. That is why our very first contribution to the common cause was a regiment of railroad men; that is why every civil engineer who can possibly do so should volunteer for service.

We are just now going into the war; we confidently anticipate that in no event will the war come to us. It is all very well for us to say that the industrial rôle of the civil engineer in backing up the war is insignificant. But if we had been for three years holding off a constantly attacking and numerically superior enemy, with the coal fields of Pennsylvania, West Virginia and

(Concluded on page 652)

The U-65, one of the large German submarines with two guns permanently mounted on deck

The Submarine Problem—V.

Some Points in the U-boat Campaign

By Percival A. Hislam

IN spite of the immense quantity of matter that has been written about them, German submarines and everything relating to them remain nearly as big a mystery as ever. Except for an isolated fact here and there, we know practically nothing about them except their record of destruction, and even that is by no means complete. It is true that the British, French and Italian governments issue a weekly return of their shipping losses, but the losses of the rest of the Allied Powers and of neutrals are not recorded in any authentic form, while in the British return—which is, of course, the most important of all—no distinction is drawn between ships sunk by mines and sunk by submarines, nor is the aggregate of the sunk tonnage indicated. As a general rule it is safe to assume that if a ship is sunk by a mine, that mine has been laid by an enemy submarine, but there are doubtless many exceptions to that rule. One has only to mention the fact, made public recently by the First Lord of the Admiralty, that German mines have been encountered off the Cape of Good Hope and in the Indian Ocean, to show that the wily Teuton has found some other means than the U-boat of getting his mines to sea.

There is quite a general impression that the recent increase in the destructive activities of the U-boat are due to its working many hundreds of miles out in the open sea, where the chances of tracking it down and destroying it are reduced almost to nothing. This is only true in part, generally speaking, although the submarine is, as the U-53 and the "Deutschland" have shown, capable under certain circumstances of much more extended work; the menace is bounded by an imaginary line drawn at a distance of 250 miles to sea from the western coast of Europe. The infested area extends from the neighborhood of Archangel to Madeira, and from one end of the Mediterranean to the other. The bulk of the sinkings take place in the Mediterranean and inside a line drawn from Brest to Bergen round the British Isles; but the total area in which German submarines are regularly operating may be put down as over rather than under 3,000,000 square miles, and approximately equal to the superficial extent of the United States.

The destroying efficiency of the submarine has been considerably increased by its growth and augmented staying power; though when, as is the case with the U-boats, they have to run the gauntlet of the Allied patrols in getting in and out of the North Sea, it is clear that there is a size beyond which it is not wise to develop them, apart altogether from the difficulties of diving and of underwater navigation which have to be contended with when the length exceeds about 250 feet. In the early days of the war there were frequent stories of 5,000-ton submersibles being under construction in German yards, of boats being prepared for conveying an army of invasion to England, and similar improbable, if not altogether impossible, tales. One still comes across occasional essays of the same character; but there is every reason to believe that the bulk of Germany's underwater work is being done by vessels whose displacement ranges from 800 to a maximum of 1,200 tons. The almost universal arming of British merchantmen may have exercised an influence on tonnage which is not yet apparent. When these vessels were unarmed the submarine could cruise on the surface, stop her victim with a hail or a single shot, and sink her by opening the Kingston valves and putting a bomb or two in the hold. But the submarine is shy of guns and does not care to face anything even as big as a three-inch. Consequently, as she can no longer cope in security with her victims on the surface, she is compelled to trust to the torpedo, and as even 14-inch torpedoes weigh about 750 pounds apiece, the number of destructive agents that can be loaded for each cruise is very limited, to say nothing of the fact that even with the advantages which the submarine possesses she probably fires off two or three torpedoes for every hit made. A submarine commerce-destroyer that fights with torpedoes is under a tremendous handicap in comparison with one operating with guns against an unarmed enemy, which was the position enjoyed by the raiding U-boats in the early stages of the war.

There is a good deal of uncertainty as to the endurance of German submarines. Early in 1915, when their principal hunting ground was off the south of Ireland, their program, according to Read-Admiral A. W. Grant, U. S. N., was as follows: Voyage out, 4½ days; working on station, 20 days; voyage home, 4½ days rest and refit, 12 days. The distance to their war station from Heligoland round the north of Scotland was 1,350 miles, so that the average speed out and home was exactly 12½ miles an hour. That average would not, of course, be maintained on the "beat," otherwise the mileage for the whole cruise would work out to 8,700.

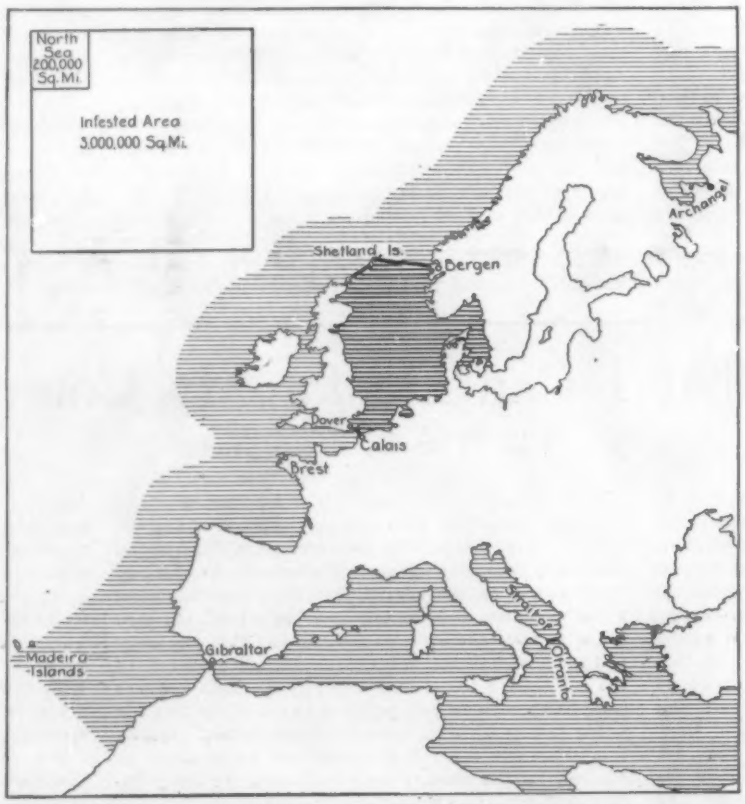
Two interesting but unfortunately contradictory statements on this question of endurance have recently been made officially in Germany. On December 19th, 1916, the London *Daily Mail* quoted a communique issued by the Berlin Admiralty to the effect that "one of our submarines, which recently returned to harbor from an expedition, remained at sea for no less than 55 days without entering a harbor or receiving assistance of any kind. Such an achievement had hitherto been regarded as impossible." On May 8th, 1917, however, the same journal quoted another official communique relating to a U-boat which had almost been given up, but which returned after establishing "*a new record* of remaining away from its base 41 days uninterruptedly, in the Mediterranean." It will be remembered that the U-51, which sank the British battleships "Triumph" and "Majestic" off Gallipoli, in May, 1915, was reported to have made the journey from Heligoland to Constantinople (about 4,400 miles) without any external assistance. In the case of the U-53, however, which was the first foreign war submarine to visit the United States, there is little doubt that she was aided by an auxiliary which may have been either a neutral or a vessel of the "Deutschland" type.

It must be remembered that every warship is a compromise, and that any one feature can be expanded enormously if the others are correspondingly sacrificed. The "Deutschland," whether rightly or wrongly, was said to carry 750 tons of cargo, in addition to her "personal" stores. An 800-ton Diesel-engined submarine cruising on the surface at eight knots will consume 10 tons of oil per 1,000 miles, so that on this basis, and with her own fuel storage thrown in, the "Deutschland" could apparently have been made capable of cruising 80,000 miles without replenishing fuel! Such a vessel as this could obviously keep an ordinary flotilla going for some time, and there is no doubt that the Germans have developed the "submarine depot ship" on a fairly generous scale. By this means the fighting vessels are enabled to spend a much greater proportion of their total "life" on active employment, while equally important is the fact that they have to pass less frequently through the most hazardous zones. For the same amount of work a 20-day submarine would have to cross the North Sea six times against the twice of the 60-day boat.

One hears and reads many estimates put forward on various grades of authority, but the plain fact is that there is practically no reliable information available regarding the essential features of the submarine campaign. We do not know the German rate of output, or even the number of boats in service at any moment since the outbreak of war. We know nothing—rumor apart—of the rate of loss; and although the British Admiralty is frequently criticized in its own country for not making public what it knows in this matter, it must be borne in mind that U-boat losses have probably covered and re-covered the following field:

1. Captured.
2. Stranded and interned.
3. Sunk and salved or located.
4. Engaged in action—seen to submerge, but fate unascertainable.
5. Mined.
6. Lost through structural defect, faulty navigation, collision, explosion caused by careless or inexperienced crews, escape of poison gas from batteries, and the ordinary perils of shipping.

The British Admiralty may have some means of access to the secret archives of the Reichsmarine-Amt, but apart from that its knowledge cannot extend beyond the first three of the above headings and even if it were known exactly how many of these craft were being put out of commission by all causes, that would be only half the tale. Such a figure possesses significance only as it is in excess or short of the maximum possible output of U-boats. This we can never hope to know; so the submarine problem is, and must remain, an indeterminate one.



The insert gives a comparison of the area of the North Sea with that of the entire infested region

Map of the submarine infested areas showing where nets could be placed to curb the U-boat

Sectional Automobile Bodies

OF importance to car manufacturers and owners alike is the development of an automobile body which is built in sections and held together by a few bolts. The novel invention is of particular value at the present time when the shortage of freight cars is acute, for the sectional body may be packed for shipment in a case no larger than that required for the chassis alone, and as a result the capacity of a box car is more than doubled. The saving that such an improvement means to builders of motor cars and shippers should run into huge figures if the device is adopted to any great extent, and more important still to the general public is the fact that freight cars may be released for other transportation of vital importance, such as the hauling of food, supplies and munitions. Prompter deliveries than would otherwise be possible should result from the ability to load twice as many autos in a box car than it will contain by the present method.

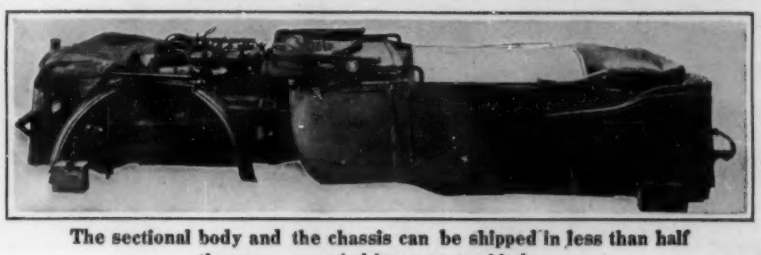
Oddly enough it was not a progressive American manufacturer of automobiles who developed this idea, but a South African, Mr. Robert Booth of Johannesburg, who was engaged in the shipping business and was impressed by the cumbersome form and size of car bodies packed for shipment. For several years he worked upon a type of body that could be assembled and knocked down and finally succeeded in building one composed of panels almost flat. The sectional body was given a thorough test in England, and was mounted upon a chassis that traveled a thousand miles over all kinds of roads without working loose at the joints. No tightening of the bolts was required, and no squeaks or rattling noises indicated any tendency to work apart under the vertical and lateral movements of the motor car.

The body rendered as good service as if it were in one piece, and there was nothing in its appearance to indicate that it was not a standard body. The joints are all covered by beading, and the lines are as graceful as those of any modern car. Of course the principle of building the body in sections can be applied to almost any model now in use.

The body is mounted upon continuous runners or sills which afford this advantage, that the assembled body is a unit apart from the chassis and great additional strength is obtained thereby. The further advantage of the body sills is that the rear seat of the car, with its side panels and doors, can be removed as a unit, so that a four-passenger machine can be converted into a runabout in a few minutes. A metal boot can be substituted, or for commercial purposes a light delivery body can be placed behind the driver's seat. For use on the farm, this feature is of further value, as by placing a fifth wheel over the rear of the chassis the light car is fitted to receive a semi-trailer of capacity up to a ton.

A point of considerable merit to the car owner is the fact that a car built in sections is easily repaired in case of collision or other accident. If an ordinary one-piece body is badly dented, it is an expensive and tedious job to repair it, while the sectional body allows for speedy replacement of the panels at a low cost.

The parts of the sectional automobile body



The sectional body and the chassis can be shipped in less than half the space occupied by an assembled car

The sectional automobile body ready for its case

The assembling of an entire body requires only about half an hour for a couple of men, while the removal of the rear seat or one of its panels is the work of a few moments.

The panels are easily removed, because it is only necessary to turn back flaps of the upholstery to reveal the bolts that join the parts.

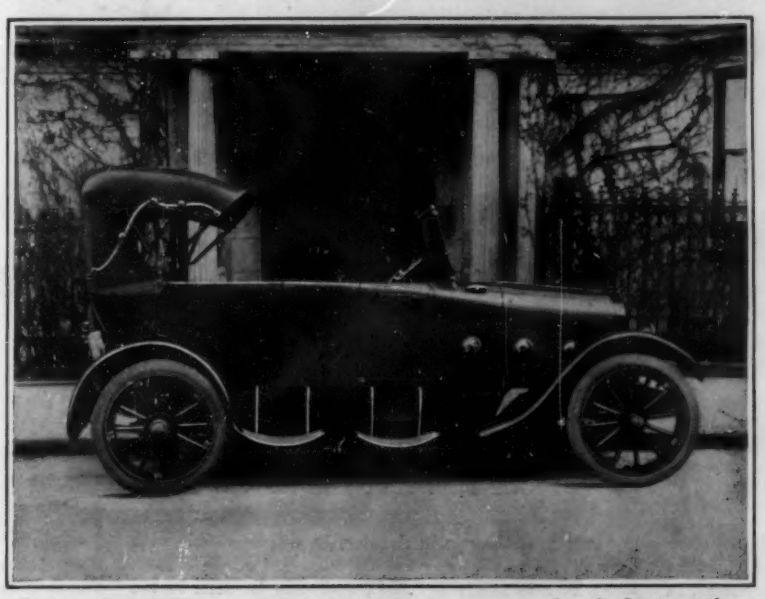
Aside from the compactness of this body for shipping, the fact that it may be stored in very small space is a decided advantage to the dealer or distributing agent for automobiles, as it makes an excessively large storage warehouse unnecessary. This means a great deal in a city like New York, where the rental is high for every square foot.

The saving in manufacture, shipping and storage should eventually benefit the car buyer, as it will result in substantial lowering of the cost of production. The body now in New York was shipped from England in a case 6 feet by 5 feet by 26 inches with a content of 66 cubic feet, while the same body, a four-passenger model, if built in one piece would require more than 166 cubic feet of space when packed for shipment. The saving of 100 cubic feet in shipping a single body is a matter of importance at a time when freight cars and ships are so desperately needed. When this saving is multiplied by the number of cars shipped annually, the figures are staggering, and the revolutionary possibilities of this invention are realized.

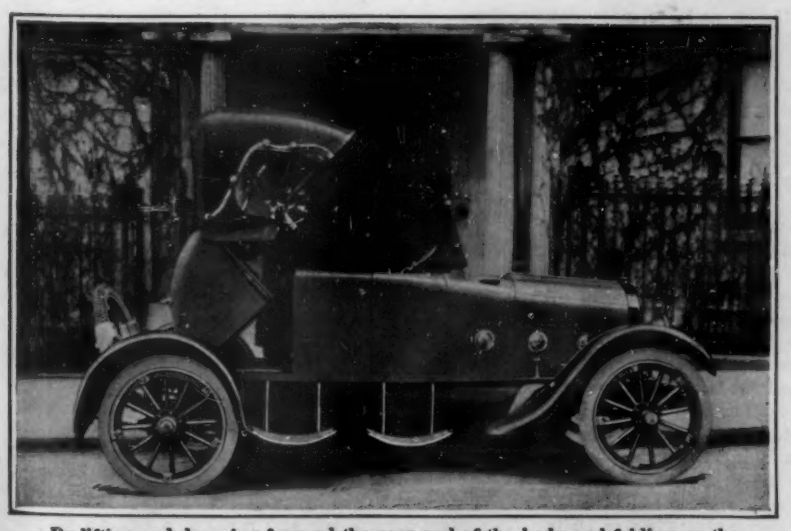
Changing the Automobile From a Touring-Car To a Roadster Model in Two Minutes

AN automobile body that can be converted from a two-passenger roadster model to a five-passenger or seven-passenger touring car in two minutes is among the latest innovations in the motor-car world. The new body is the invention of Mr. Carrm, a native of Buenos Aires, Argentina, now residing in the United States, and is said to represent 13 years of constant development work on the part of the inventor.

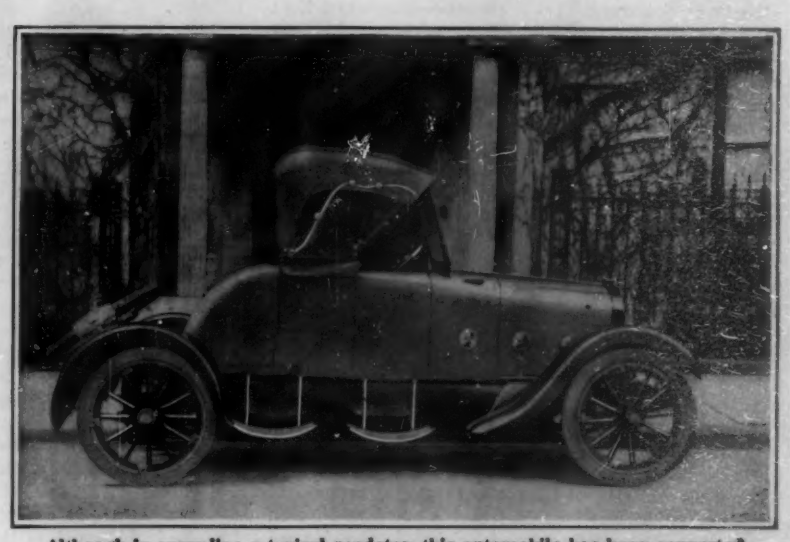
The new convertible automobile body can be built to fit any chassis, whether light or heavy or short or long. It is absolutely foolproof, according to the inventor's claims; and so ingeniously is it constructed that a novice can operate it without the slightest difficulty. A simple adjustment releases the rear end of the body so that it can instantly drop back, forming the tonneau as shown in the accompanying illustrations. The doors, which are folded compactly into the seats, can then be opened out to form the usual doors. When used as a roadster the doors are enclosed with the two folding seats in the rounded-off portion of the body, and the tire holder slopes forward so as to give the car a true roadster appearance. There is absolutely no bulkiness in the appearance of the car, and, on the other hand, when the car is arranged as a touring model for seven passengers it has an amazing amount of leg room in the tonneau. In no wise is the convertible body freakish in design, and on the contrary it can be made to conform with the best of either European or American body designs. The economy of carrying what practically amounts to two bodies on one chassis is obvious.



In two minutes this roomy, seven-passenger car, representing the best practice in body designs, is transformed into a handsome roadster



By lifting and dropping forward the rear end of the body and folding up the doors the conversion is readily accomplished



Although in every line a typical roadster, this automobile has been converted from a seven-passenger touring car in two minutes

The Heavens in July, 1917

Observations of Great Scientific Interest Made by Amateur Astronomers

By Prof. Henry Norris Russell

IT is still possible for the amateur astronomer, with a telescope of moderate size, to make observations of great scientific interest and importance, if only he has the intelligence to observe carefully, and report accurately, anything unusual which he may happen to see.

A very good instance of this is afforded by certain observations of the occultation of a star by the planet Saturn made last February by two English amateurs.

It has long been demonstrated, by various lines of reasoning, that the rings of Saturn were not continuous solid masses, but were composed of a cloud of separate particles, each following its own orbit about the planet. In the innermost of the three rings, often called the "crape ring" these particles are so thinly scattered that the ring appears less luminous than the others, and is partially transparent, so that the body of the planet can be seen through it. The middle one of the rings appears almost as bright as the planet itself, and is probably practically opaque—a conclusion confirmed by Professor Barnard's observation of an eclipse of the distant satellite, Iapetus, by the shadow of the planet and rings. While the satellite was distinctly visible, in the shadows of the crape ring, though fainter than usual, it vanished altogether when it was in the shadow of the bright, middle ring. Unfortunately, on this occasion the eclipse could not be followed until the satellite got into the shadow of the outermost of the ring, so that it remained doubtful whether this ring, which is much fainter than the middle one, was partially transparent or not. The nature of the "Cassini" division, between the outer and inside ring, which is about 3,000 miles wide, and very dark, was also not quite certain, though it appeared probable that it was a real gap, through which the dark sky was visible.

About three years ago, an English amateur astronomer, Mr. P. H. Hepburn, on examining carefully some photographs of Saturn taken by Professor Barnard with the great Mount Wilson reflector, noticed that the ball of the planet was apparently dimly visible through the outer ring—an impression confirmed by Professor Barnard after his attention had been called to the matter. But, though this made it very probable that the outer ring was partially transparent, there are so many complications and tricky illusions possible in the photography of delicate details that it seemed a little premature to speak of the transparency of this ring as a fact.

The fortunate observations by the other amateurs mentioned above have finally dispelled all doubt.

On the evening of February 9th of the present year, Mr. M. A. Ainslie, a Naval Instructor resident at Blackheath, near London, looking at Saturn with his 9-inch reflecting telescope, noticed a star of the seventh magnitude close to the north pole of the planet. Returning to his telescope later, after being called away by other duties, he found that the planet had passed over the star, which now appeared, in the midst of the ring, and on the line of the Cassini division, as a very conspicuous small white spot. The planet's motion was such that the star apparently drifted along the division for about fifteen minutes, and then passed outwards to the outer ring. Even when behind this ring, however, *the star was still visible*, though with greatly reduced brightness, and was followed for forty minutes, after which the planet passed away from in front of it, and it was seen isolated on the sky. Twice during its passage behind the outer ring the star brightened up notably for a few seconds—doubtless because it was seen through two of the five divisions which are sometimes noticed on this ring.

The same phenomena were also observed by another amateur, Mr. Knight of Rye, with somewhat less detail, since he had only a 5-inch telescope.

Calculation from the known dimensions, position and motion of the planet, and the position of the star, show that it must actually have been visible through the Cassini division at the very time when Mr. Ainslie observed it, coming out from behind the outer ring just when he saw it brighten up.

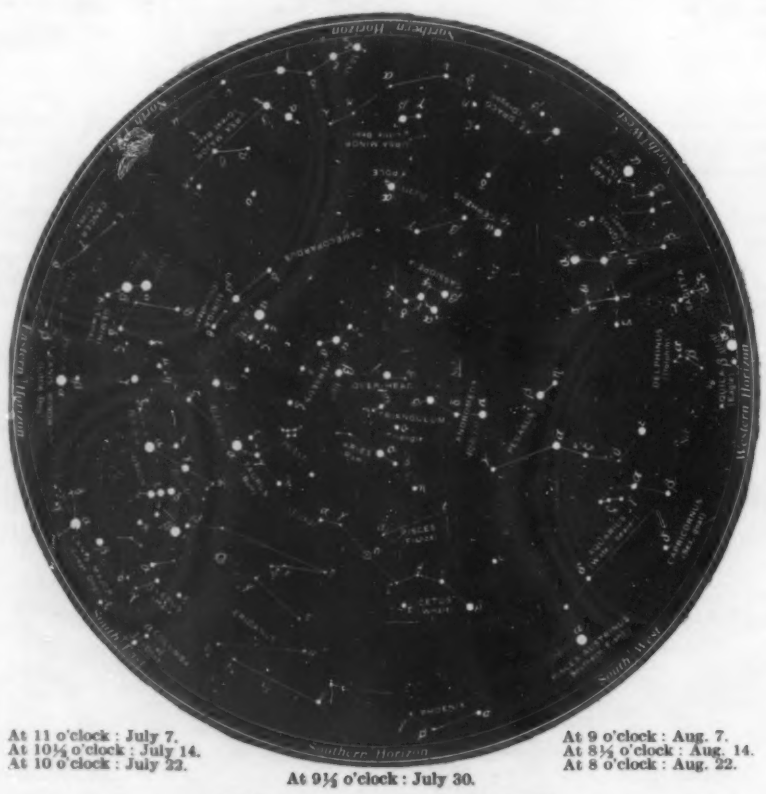
These observations show beyond any possible doubt that the outer ring of Saturn is actually composed of particles so sparsely scattered that a star can be seen through the ring, and that the divisions in the ring are actual open spaces through which the sky behind is seen. The importance of making such observation, if the opportunity should offer, has been recognized by astronomers for more than fifty years. The fact that they have at last actually been secured by amateurs, with telescopes of moderate size, should be to the highest degree encouraging to other such students of the heavens.

The Heavens

The familiar summer constellations are clearly shown upon our map. In the east is the great square of Pegasus, where Wolf's Comet is now to be found, with Andromeda on the left, and Aquarius on the right. Higher up are Cepheus and Cassiopeia, in the northeast, Cygnus, in the east, and Aquila, in the southeast; Capricornus, Sagittarius and Scorpio are low in the southeast and south Ophiuchus and Serpens are above the latter, and Hercules and Lyra still higher, right overhead. Corona and Boötes are high in the west, and Vega is sitting below. Ursa Major is in the northwest, and Draco and Ursa Minor high in the north.

The Planets

Mercury is a morning star at the beginning of July but passes behind the sun (through superior conjunction), on the 12th and becomes an evening star. Being however near the sun in the sky, he will be visible with difficulty, if at all, except at the very end of the month, when he sets about 8 P. M., and may be seen in the twilight if the air is clear. At this time he is in Leo, near the bright star Regulus, but fully a magnitude brighter.



At 11 o'clock : July 7.
At 10½ o'clock : July 14.
At 10 o'clock : July 22.

At 9 o'clock : Aug. 7.
At 8½ o'clock : Aug. 14.
At 8 o'clock : Aug. 22.

At 9½ o'clock : July 30.

NIGHT SKY: JULY AND AUGUST

Venus is an evening star in Cancer and Leo, setting at 8.40 P. M. on the 1st and 9.28 on the 31st, and by this time conspicuous after dark. She is in conjunction with Saturn on the 4th, being a little over a degree north of him. Both planets will be easily visible in the twilight.

Mars is a morning star in Gemini rising about 2.30 A. M. in the middle of the month. He appears like a red star, nearly equal in brightness to Castor, and inferior to Pollux.

Jupiter is also a morning star in Taurus, rising about 1.20 A. M. on the 15th, and is the most conspicuous object in the morning sky.

Saturn is an evening star in Cancer at the beginning of the month and is visible just after sunset, but he will soon be lost in the twilight, and, on the 27th, he passes through conjunction and becomes a morning star.

Uranus is in Capricornus, and not far from opposition, which occurs in the middle of next month. His position on July 2d is 21h. 43m. 24s. R. A. and 14° 28′ 17″ south declination. On the 30th he is in 21h. 39m. 52s. and 14° 46′ 46″ south, so that he moves almost a degree in the four weeks, in a southwesterly direction. On the 10th he is due north of the third magnitude star Delta Capricorni, at a distance of slightly less than two degrees. There are two or three faint stars in the vicinity, about as bright as the planet, but he may easily be distinguished by means of his motion, if one makes sketches of the positions of the stars in the field at intervals of a few days.

Neptune is in Cancer, and is in conjunction with the Sun, on the 27th, within a few hours of Saturn, so that at this time the Earth, the Sun, and these two planets are very nearly in one straight line. Needless to say, he is unobservable during the month.

The Moon is full at 5 P. M. on the 4th; in her first quarter at 7 A. M. on the 11th, new at 10 P. M. on the 18th, and in her last quarter at 2 A. M. on the 27th. She is nearest us on the 6th, and farthest away on the 22d.

As she sweeps around the sky, she passes near Uranus on the 7th, Jupiter on the 14th, Mars on the 16th, Saturn and Neptune on the 19th, Mercury on the 20th and Venus on the 21st. Moreover, at the times of both new and full moon, eclipses occur. The eclipse of the Sun, on the 19th, is visible only in a small portion of Antarctica and the adjacent ocean, south of the western part of Australia, and even then appears only as a very small partial eclipse. It is improbable that it will be seen by any human eyes.

The lunar eclipse of July 4th, on the contrary, is total, and of unusual magnitude, the Moon passing almost centrally through the Earth's shadow. It is visible, in whole or in part, throughout Europe, Africa, and most of Asia, and the ending can be seen also in South America shortly after the Moon has risen: but, since the Moon leaves the shadow at 6.25 P. M. by Eastern Standard Time, there will be nothing left to see when it rises over our part of the world.

Wolf's Comet

This comet, which has been under observation so long on its inward journey toward the Sun, is now favorably placed for observation. It passed perihelion on June 16th, but is still getting nearer to the Earth, since we are gradually overtaking it, and coming more and more nearly into line between it and the Sun.

On July 1st the comet will be in R. A. 22h. 48m. 36s. Decl. +24° 32′, about 3° south and 3° west of β Pegasi. During the month it will move slowly eastward, passing south of β Pegasi, at a distance of 3° on the 8th, and continuing at first due east in the sky, and then a little to the southward, until, on August 1st, it will be in 23h. 29m. 13s. +22° 10′ or 7° east and 5½° south of β Pegasi. Though far brighter than at discovery, and showing a perceptible tail when viewed telescopically, it will probably be too faint to be seen with the naked eye. The reason for this is its great distance from the Sun and Earth.

Even at perihelion it is 157,000,000 miles from the Sun, and during July it will be several million miles farther away, while its distance from the Earth varies from 106,000,000 miles on July 1st to 95,000,000 miles on August 1st.

Had the comet come as near the Sun as did Halley's Comet, for example, it would have been a conspicuous object.

PRINCETON UNIVERSITY OBSERVATORY.
June 18, 1917.

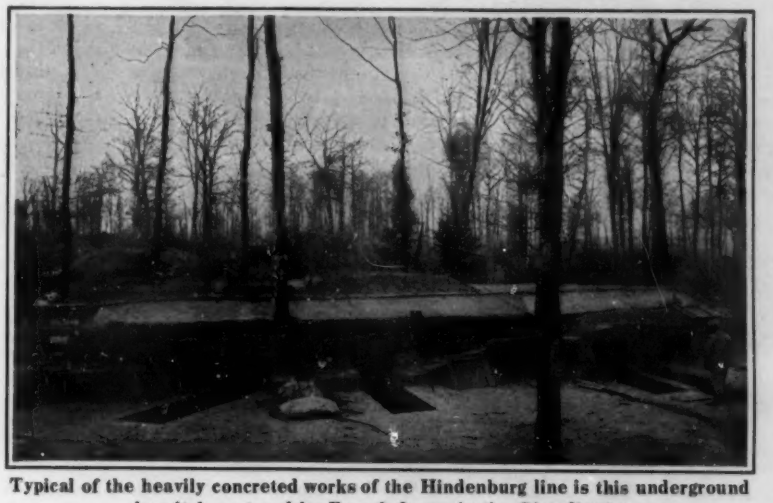
The Quartz Spectrograph of the Lick Observatory

PARTLY with the aid of a grant from the Draper Fund of the National Academy of Sciences, the Lick Observatory has acquired a new spectrograph designed for observations in the ultra-violet region of the spectrum. The optical parts of the instrument are of quartz, as ordinary glass is opaque to ultra-violet light. The spectrograph is so mounted that it may be used either as an ordinary slit instrument or as a dispersion device, forming with the telescope a prismatic camera. In its latter capacity it is now being used in spectroscopic studies on the brighter planetary nebulae. When a nebula is photographed with this instrument a separate image of the nebula is recorded on the plate for each line of the nebular spectrum. In a given nebula these images are frequently unlike, and the instrument is being applied to the investigation of these irregularities. The spectrograph has also revealed a number of previously unobserved lines in the ultra-violet.

A Red Cross Shelter in the Hindenburg Line

THAT the Hindenburg line is something more than an imaginary line of defense is becoming more and more apparent as the Entente forces succeed in snatching here and there bits of this vaunted bulwark of the Germans in France. Already the British and French have captured hundreds of heavily concreted and armored machine-gun and artillery emplacements which have been so well designed and constructed that the German commanders were certainly justified in placing so much faith in them, even to the extent of pronouncing them impregnable.

Typical of the works found in those portions of the Hindenburg line already conquered is the Red Cross underground shelter shown in the accompanying illustration, which fell into the hands of the advancing French forces in the region of Bailly, in the Oise district. Here is a subterranean shelter provided with a roof of stout timber and concrete which would seem impenetrable to all but the heaviest shells from Entente artillery; and it goes without saying that it is indeed a tribute to its builders, even if they are our enemy. Still, as has been frequently pointed out in these columns, the very elaborateness and the sense of security engendered by such works has had a detrimental effect upon the morale of the German forces, while the comparatively crude works of the Entente forces have kept up the attacking spirit of the men who have no special inducement to remain snugly in dugouts provided with every comfort of home and seemingly secure from danger.



Typical of the heavily concreted works of the Hindenburg line is this underground hospital, captured by French forces in the Oise district

Activities of the French Land Fleet

ENCOURAGED by the initial success of the land battleships or "tanks" introduced by the British forces during the battle of the Somme, the French some time ago developed and introduced tanks into their army. In a previous issue of this journal there appeared a photograph of the first of the French tanks, as well as a short description of this machine which varies only in outward appearance from the general design of its British brother-in-arms.

The French tanks took a conspicuous part in the recent battle of the Aisne and were cited for their splendid work by General Nivelle. The commander of the French forces stated that the victory of his troops was in large measure due to the daring and skill of the crews of the tanks, or *artillerie d'assaut* as they are known to the French.

In one of the accompanying illustrations appears a fleet of French tanks parked back of the lines. The machine in the foreground offers ample opportunity to study the curious prow of this type, as well as the propelling mechanism which, it appears, is less exposed to shell fire than the tractor belt of the British type. The French tank is equipped with two or more short-range quick-firing cannon of three-inch caliber, and a number of machine guns. This armament should make it a formidable engine of war aside from its tremendous crushing powers. Heaped on top of each tank is the painted canvas which is drawn over it to conceal it from enemy aeroplanes. In accordance with British custom, each French tank carries an arbitrary name, the one in the foreground being known as the *Fleur d'Ajoine*, while the one to the right of it is known as the *Pourquoi Pas*.

The second illustration shows the latest French tank to make its appearance on the battlefield. This machine, which is considerably larger than the earlier French tanks, is known as the St. Chamond tank. It is armed with long-range cannon and machine guns, the latter being used through the usual loop-holes on the sides of the tank as well as in the turrets. The propelling mechanism of the latest tank is similar to that of the smaller type; in fact, in general design the tank is identical with the earlier French design. As yet the super-tank has not asserted its offensive capabilities on the battlefield, but its immensity and power are unquestionable.

The Current Supplement

THE current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2165 for June 30th, is indispensible to all readers of the publication, as it contains the *Index* of the volume, including all issues from January to June, inclusive, of which it is the final number. *Travel Notes in Western Venezuela* gives an unusually interesting account of explorations in a picturesque and primitive region, and it is illustrated by a large number of exceptionally fine photographs. *Chronology of the Egyptian Pyramids* discusses some scientific problems suggested by details of construction found in them. It is accompanied by several diagrams. *A New System of Weather Prediction* promulgates a theory by which conditions can be predicted months in advance. It is illustrated by a number of curves. *Experiments with Rotating Disk and Peripheral Alaries in Mechanical Flight* gives some notes and a number of illustrations of an ingenious apparatus employed in investigating an important problem in aviation. *The Submarine Boat* is a short history of this class of vessels. *Should the Government Build Wooden Ships?* reviews some pertinent facts connected with the proposition. *Pressure Phenomena Accompanying the Growth of Crystals* discusses an interesting chemico-physical problem. *The Principle of Relativity* is a paper criticising one of the most important theories in physics. *Wayside Crosses in England* describes in an interesting manner these old monuments that have an archeological value. It is accompanied by a number of pleasing sketches. *Instruments for Testing the Curvature of Optical Lenses* describes some devices of considerable value in the optical workshop. *Effect of Corrosion on the Ductility and Strength of Brass* is an investigation of some of the causes of failure in this class of alloys that have occurred in recent times.

There are a number of shorter articles and notes of distinct interest. Among these is *Experiments on Ascaris Infection in Hong Kong*, a disease which is extremely common in this region. *Making Lantern Slides from Line Diagrams* gives valuable hints to those who have this class photographs to make. Other notes are on *Poisoning by Primroses* and *Effect of Impurities in Producing Turbidity or Opacity in Glass*.

Copyrighted, Underwood & Underwood

A veritable land dreadnought is this latest of French tanks, known as the St. Chamond type

Copyrighted, International Film Service

A fleet of French land ships or tanks behind the lines between trips over "No Man's Land"

Playing Hide-and-Seek With the Guns at the Front

AFTER all is said and done, the battle of today is a serious game of hide-and-seek on a vast scale. For no matter how well protected a gun may be, no matter how powerful it may be, the best protection for that gun is not in a thick shelter of concrete and steel, but in a thin layer of appropriate paint or a few armfuls of green branches from a nearby tree. Once the position of a gun is ascertained by the enemy, it is a simple matter for him to destroy that gun by one or more well-directed shots, and perhaps one of his airmen, flying overhead, may dispose of that gun by a neatly-placed bomb. At any rate, in the case of two armies of equal strength it is generally the one who hides his guns best who comes out the victor.

The high degree of skill shown in the concealment of guns is depicted in the accompanying illustration. Here is a gun emplacement in the side of a hill, built of steel and concrete and then covered with sod so as not to arouse the suspicions of enemy airmen or observers. Still further to conceal the gun emplacement, it will be noted that screens are provided to cover the apertures. These screens consist of heavy iron frames covered with canvas painted in such colors as to make them unnoticeable. When the guns are to be fired the screens are raised, after which they drop in place again giving the hill a perfectly innocent appearance. Indeed, it probably requires weeks of patient observation before one of these emplacements can be discovered by the anxious enemy, and as likely as not many of them are never located.

Copyrighted, International Film Service

A cleverly concealed emplacement for guns, provided with canvas-covered iron frames to mask the apertures. The shelter is here shown in course of construction

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

A Surgical Sewing Machine

By Robert H. Moulton

A CHICAGO surgeon, Dr. E. Wyllys Andrews, has invented an apparatus designed automatically to repair surgical incisions. Instead of being "sewed up" by hand on operating tables, future sufferers from appendicitis may fight out their troubles on a surgical sewing machine of the type about to be described.

For a number of years Dr. Andrews tried to perfect a sewing machine for wounds, constructed with platen, fixed needle and bobbin or shuttle. Yet in spite of the fact that several small hand and toy machines are made small enough to handle easily, none of them is capable of being brought into cavities or depths of wounds, or can be easily sterilized. Moreover, the machines in question place only what are called mattress stitches, no matter whether one or two threads be used, and cannot be easily adapted to overhand glover or interrupted stitching. After much study of the problem and discussion with the manufacturers of various machines, Dr. Andrews became satisfied that there could never be designed a shuttle machine that would be anything but clumsy, heavy and inefficient, and therefore dangerous about a wound.

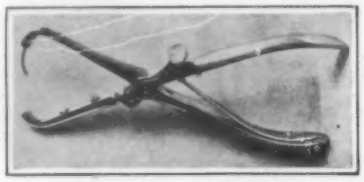
It is different with forceps. With these, surgeons are familiar and know that they can place them in all sorts of deep and superficial locations even more readily than the hands or fingers. Dr. Andrews, therefore, set about to design forceps which would automatically insert stitches carrying threads by merely opening and closing their blades, thereby combining some of the speed and accuracy of the sewing machine and the nicety and safeness of hand-sewing. The result of his experiments is a set of forceps which will actually sew the skin and deep layers more smoothly and rapidly than by hand. They are equally adapted for placing deep ligatures, single or multiple.

The object of these instruments is to gain speed, and, incidentally, regularity of spacing and of tension in the approximated edges. It must be admitted that this is as likely to be a drawback as an advantage. No machine can have the delicacy and tactile sense of the human fingers. But the question is, how much time can surgeons afford to sacrifice for careful suturing by the fingers?

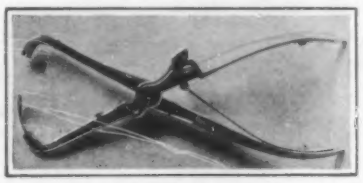
A comparison of work in different clinics shows that some surgeons suture wounds rapidly. But the most of them require a large percentage of the total time of the entire operation for final closure, and nearly all take longer for this step than they themselves realize or would believe unless they have been timed by the watch.

A very few surgeons can perform certain ordinary operations, including the internal work and the closing of the wound, in five minutes, but the majority take from ten to fifteen minutes, while some very conscientious workers require from ten to twenty minutes for their careful wound closure alone. This is admirable from an anatomical standpoint, but it also involves the question of the injurious effect of prolonging anesthesia even in simple cases. Yet the safety of the wound closure should never be sacrificed to speed. It is an inherent fault of hand suturing that it must be somewhat slow or else somewhat imperfect. Long practice with the needle gives speed, but only up to a certain point. To get beyond this point mechanical devices of some sort must be employed.

Dr. Andrews' device consists of a forceps with a needle, carrying a thread, at the end of one blade. When the handle of the forceps is closed the needle passes through the flesh and is seized automatically by the opposite blade, at the same time carrying the thread through the tissues. By pressing a thumb catch near the middle of the forceps the needle is released from the second blade and returns to its original position in the first blade, and thus is made ready for the next stitch, the operation requiring but a fraction of a second. The operation of the device is shown in the illustrations



Before the stitch



—and after

Three Tools in One

THIS small device attached to a saw, enables the saw to be used as a square. It consists of two flanged plates, one fastened to each side of the saw near the handle with small bolts. When held in the position shown in our first cut, it makes a 45-degree angle. This photograph shows the saw placed back of the board, showing how the plate engages the edge of the board to be marked. When the saw is held in the position shown in the second picture, it can be used for marking at right angles to the edge of the board. This is very handy and a time saver, as it saves the time of reaching for a square every time a board is to be squared.

How the square and angle are attached to the saw blade

Laying of a 45 degree angle without reaching for a different tool

Putting Life into Street-Car Advertising Cards

IMAGINE the Gold Dust Twins hard at work, one scrubbing the floor and the other scouring and polishing a pan; the Onyx hosiery girl raising a bit of her skirt and revealing her silk hosiery; the wearer of a Stetson hat tipping to every passer-by—visualize, if you can, all these things and many others like them in the space now occupied by the inanimate street-car advertising cards, and you at once begin to appreciate what animated advertising would mean if introduced commercially.

Bert Green, of New York city, is the inventor of the animated street-car advertisement; and incidentallly, though appropriately, he is the manager of the animated cartoon department of a leading film producer. Mr. Green has devised a number of movements which, when applied to street-car advertising signs, cause the figures in the advertisement to become animated. The movement is entirely due to the motion of the street-car in passing over the rail joints and in starting and stopping; there is absolutely no clock work nor any electricity required to operate the mechanism. Furthermore, the inventor has succeeded in reducing his mechanism to a point where the whole of the animated advertisement may be kept within one-half inch thickness, and it is so curved that it can be clipped in place in the usual way.

There are two forms of movement which Mr. Green employs at the present time, although there is almost no end to the forms which may be developed and applied successfully. One of these movements is shown in the accompanying illustrations, and consists simply of a tube containing a metal ball. Obviously, when the car starts the ball is thrown backward, and when the car is brought to a stop the ball is thrown forward with reference to the direction in which the car is traveling. It will be noted that the ball, in moving back and forth, strikes end members which in turn are connected to and operate a pin member which slides in a slot, by means of a bowden wire transmission. The pin member in turn operates the animated figure of the advertisement—in this instance a man who continually tips his hat. An addition to this movement appears in the second illustration, in which it will be noted that an arrow member, coming through a slot so as to be seen on the face of the advertisement, is fitted over the ball and travels with it. This movement is most effective, since the arrow travels back and forth over a certain line that is to be emphasized in the advertisement's appeal.

Aside from the ball movement, Mr. Green has successfully employed various arrangements of pendulums, which can be used for more rapid animation, such as the nodding of a head, the winking of eyes, arm movements, and so on. The cards present an interesting and practical innovation in advertising.

A typical animated advertising sign for street cars, partially cut away to disclose its mechanism

Another variation of the animated advertising sign, in which an arrow travels over a display line as a form of emphasis

The reason a 2-ton Truck can do this—

(Carry 2 tons up steep grades)

—and the reason a 2-ton Truck can do this—

(Carry 2 tons through the heaviest kind of "going")

—is the SAME reason that a 2-ton truck CAN do this—is now doing it for hundreds of concerns all over the U. S.

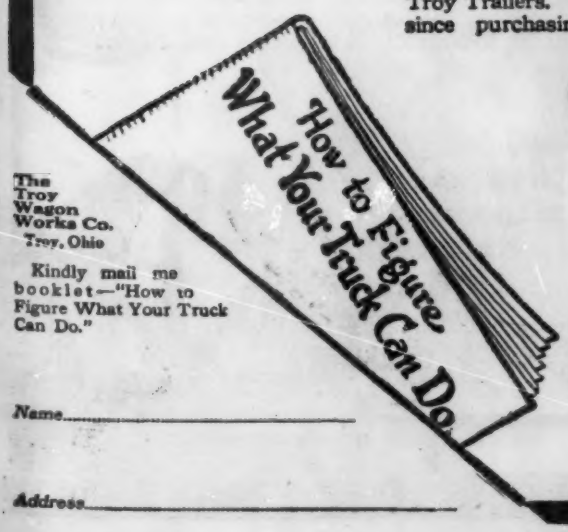
6¼ Tons with a 2-ton Truck

Troy Trailer "in daily service with these loads since July, 1915—on same tires, no repairs of any kind," at plant of Southwestern Portland Cement Co., El Paso.

The above shows what can be done under especially favorable conditions. Any good truck while loaded to it's full capacity will also pull at least as much again on a Troy Trailer.

The largest concerns in the country have cut their truck operating costs by purchasing Troy Trailers. The Ford Company say that since purchasing two Troy Trailers they "Have done the work with 3 trucks that formerly required 5."

The Saxon Motor Co. write: "We have been using a 5-ton Troy Trailer with a 3½-ton G.M.C. truck and are handling from 7 to 9 tons a trip with this outfit, and find it a very cheap way to reduce the cost of freight hauling."



The Troy Wagon Works Co.
Troy, Ohio

Kindly mail me booklet—"How to Figure What Your Truck Can Do."

Name_____

Address_____

Troy Trailers

Riker-Hegeman, New York, say their Troy Trailer saves them "Somewhere about $100 a week."

The Rapid Transit Co., Kentucky, write: "By using our Troy Trailers we can double our capacity at an actual additional daily outlay of $2, whereas the daily cost of operating a truck alone is $15."

Troy Trailers range in capacities from 1 to 5 tons. There is also a line of Troy Juniors of smaller capacity to be operated with small trucks or pleasure cars.

The Troy Wagon Works Co., Troy, Ohio

Branches or Distributors in all Principal Cities.

TEXTAN SOLES PACKING RUBBER APRONS GASKETS HIPRESS BOOTS

GOODRICH

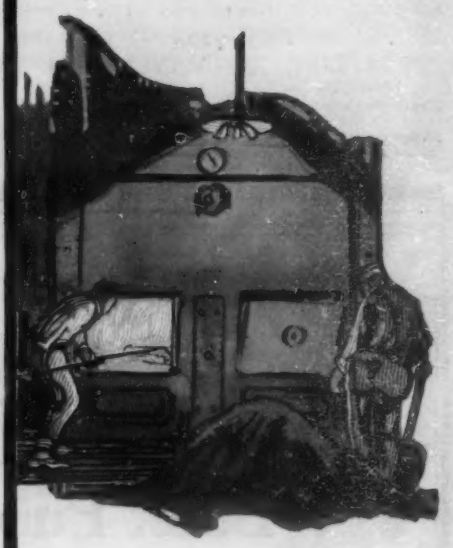
HARD by, Goodrich conveyor and elevator belts, those wonderful *step-savers* of *time* and *money*, bear unending burdens of raw material and half finished products from one department to another.

Everywhere Goodrich *oil-resisting hose* eases the thews of *iron-and-steel* laborers, and Goodrich buffers and shields safeguard the nerves, and life and limb of *flesh-and-blood* workmen.

Goodrich Truck Tires and Goodrich *Silvertown Cord* and *Black Safety Tread Tires* on motor truck and motor car are rushing distribution on seven league boots

The physical fitness of the worker is the PRIDE of the House of Goodrich. Over it is kept unrelaxing watch. Not only has the great plant at Akron a hospital, which is a model of its kind, but also a dental department from which every Goodrich employee must receive a clean bill of dental health.

Because Goodrich is a doctor who takes his own medicine, Goodrich knows what to furnish in rubber for the hospitals and hygienic bureau of industrial plants.



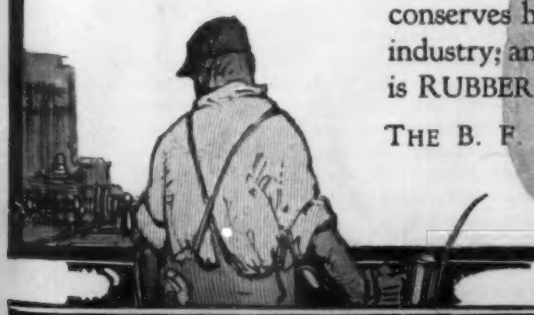
BOILER WASH-OUT HOSE
STEAM HOSE

WHEN the whistle blows, Goodrich rubber does not quit. The work of man and machine may be from sun to sun, but the work of Goodrich rubber, like the work of woman, is never done. Throughout the night as valves on the engines, it holds power in leash fot the morning's task; as *Goodrich fire hose*, veteran fire guardian of life and property keeps vigil.

That Goodrich *watchfulness* is always an unseen force in the growth and betterment of industry. It is the Goodrich intuition to know the NEWEST need of rubber as soon as the factory knows it; to anticipate the need and have it fulfilled before the industry suffers from it, is Goodrich's greatest service to factory and mill.

Because Goodrich rubber works with man; because it conserves his health and life; because it develops his industry; and means efficiency and profit, GOODRICH is RUBBER to the *work-a-day part* of the *world*.

THE B. F. GOODRICH COMPANY, AKRON, OHIO



SAW MILLS SPECIAL BELT

FAIR TREATMENT

American Supremacy of the Air

(*Concluded from page 641*)

the lines to supply the constant stream of aviators, air fighters and observers needed, and 30,000 aeroplanes are going to waste annually in allied Europe.

Presumably the German and Austrian mortality is as great, or nearly as great. The difference in favor of the Central Powers, if any exists, lies in the fact that their bird men take less risks and fly less far over enemy lines for observation purposes, demonstrated in a less accurate artillery fire, and not at all controverted by the daring cross-channel raids on London.

If it were possible to send 50,000 new planes, and aviators to the Western front tomorrow, the German air men could no longer leave the ground, her artillery would be helpless, and without artillery war is lost.

Of course, this isn't possible. Nor does the Air Craft Production Board plan any such wholesale manufacture of battle planes. In the first place, we don't know how. In the second place, if we did know how, it is somewhat problematical whether the knowledge and the battle planes of today might not be out of date by the time manufacturing processes were standardized and the first shipment reached Europe, so rapid is the progress in construction as experience shows changes and new ideas looking to greater efficiency and reliability. Again, the mere shipping abroad of such huge quantities of planes is an almost unsolvable problem.

There are two answers: One, to ship machinery, mechanics and engineers abroad to erect new factories, and make the planes over there. The other, to make training planes, releasing for battle plane manufacture every British and French plane factory, and to supply engines, engines, engines.

There are not, of course, in this country, enough aeroplane factories to supply quickly our own government's very modest demands. America invented the submarine and has been one of its victims. She perfected the aeroplane, and has fewer machines, fewer aviators, and knows less of aviation than any great country in the world. But America has also perfected factory organization, efficiency methods and standardized production in quantity, and no country has ever equalled, let alone exceeded, her in ability to make, make, make anything to which she turned her hand.

So the answer of the Air Craft Production Board to those who point the finger of scorn at our puny aeroplane factories, our almost infinitesimal resources for making aeroplane motors, is this: They have taken a complete census of every automobile and motor plant in the country. They know the factories in other lines which may quickly be rearranged for aeroplane construction. They have assembled in Washington the leading motor engineers of the country—and they are some very eminent gentlemen—to combine their great experience into one standard motor, perhaps to be called the "U. S. Motor." They have plans by which dozens of the great automobile factories can be turned into aeroplane factories, if not at a moment's notice, at least, within a very short time. True, the factories do not yet know how to make aeroplanes. But if a standard training plane, acceptable to Canadian, English and French air services is produced, mechanics can quickly be trained to make its several parts, just as any automobile factory, once the model and design are finished, and the necessary special machinery installed, can turn out an unheard of number of duplicates in record time.

The great problem has been—and still is—engines. An aeroplane engine differs from an automobile engine in many particulars. It must be strong enough for the work, without an extra ounce for dead weight. It must be reliable. It must be powerful. It must, for quantity production, be simple, yet at no sacrifice of efficiency. It is to these ends that the various motor manufacturers are working together, and the U. S. Motor—if such should be its name—will be so standardized that whether it be made as a four, six, eight, twelve or higher multiple cylindered engine, it will have cylinders alike, similar pistons, valves of the same general construction, connecting rods practically identical, ignition standard, the whole manufacturable in quantity in short time, just as one great plant in this country has shown it can turn out over a thousand complete automobiles (let alone a thousand complete engines!) a day, year in and year out. It would only take a hundred days of similar manufacturing to win the war!

The Air Craft Production Board is a practical organization. No idle theories of plane manufacture have held its attention to the exclusion of that equally important phase—man training. Three great aviation fields are now being rushed to completion, others already authorized, are being selected, training methods have been brought to us by our Canadian brethren in arms, young men are now being trained for aviation school work (6,000 aviators will be ready for service at the end of this year as a minimum and a vastly increased number if the greater program is adopted by Congress).

The Air Craft Production Board does not plan the mere training of a student in the art of flying—it is almost of secondary consideration. The airman of today must know military drill, machine gun work, artillery observation, bombs and bombing, wireless and signaling, theory of flight, types and care of various machines, tools, map reading, reconnaissance, photography, engines, motorology and something of meteorology and finally—cross-country and general flying.

The personnel of the Air Craft Production Board is as follows: Howard E. Coffin, Chairman; Brigadier General George O. Squiers, Chief Signal Officer, U. S. A., and a deep student and learned writer and authority on aeronautics since its beginning; Rear Admiral David W. Taylor, Bureau of Construction, U. S. N.; S. D. Waldon, ex-vice president Packard Motor Co.; E. A. Deeds, ex-general manager National Cash Register Co.; R. L. Montgomery, banker, of Philadelphia, and Arthur G. Cable, Secretary.

These gentlemen have summoned to their aid the greatest gas engine, production, automobile, aeroplane and efficiency engineers of the country. They have undertaken to jump the United States from last to first place in command of the air, making us, not utterly unprepared, but *best* prepared of all nations, to make defensive use of that great invention America gave to the world—the conquest of the air.

What I Can Do for My Country

(*Concluded from page 643*)

Ohio and the iron deposits of Michigan and Minnesota in his hands, our industrial establishments would conceivably have deteriorated to a point where the services of the civil engineer would be anything but superfluous. This is the case in France today. The railroads, of course, present the most critical aspect, but by no means the only serious one. With all the military and industrial engineering which we have to do, then, we can use, we need every civil engineer we can possibly get; and above all no engineer should refrain from going because he fears that he has been confined to too special a realm for his particular talents to be of use. No matter what his field of specialization, the civil engineer is wanted in France. It is too late, if he has not already enlisted, for him to be among the first to go; at least he need not be the last.

To the chemist, the mechanical engineer, the electrical engineer, the mining engineer, we have said "Stay on the job; we need you there and we don't need you in the army." When we come to address the civil engineer, in this the closing chapter of the present series, we find at last a technical man to whom we can appeal in another vein. He is the man we need in the army, and by great good fortune we do not need him—at least not badly—at home. So to the civil engineer we say without reserve "Enlist and go to France."

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Stragetic Moves of the War, June 21st, 1917

(Concluded from page 642)

long-range guns now in use have been taken from German warships to make up deficiencies; there seems to be a general complaint on their part of a lack of sufficient artillery to cope with the British armament. Latest reports give heavy artillery actions east of Rheims, resulting in the capture of German trenches. Evidently the French wish to press forward and straighten their lines in the hill country that covers the German flank defending Laon on the east.

The principal scene of operations on the Italian front has shifted from Gorizia, the Carso plateau, and the advance on Trieste to northern Italy where around Asiago, Arsiero and the Val Sugana fighting is going on with varying success for an advance on Trent, the object of so many former battles. The hostilities begun here by the Italians as the aggressors, have no doubt had in view the drawing off of troops from other fronts, notably the Carso and thus reduction of the military pressure on the latter.

Now that the question of the hostility of King Constantine and the attitude of Greece have been settled, some aggressive movements of the Saloniki armies can be expected. For more than two years these troops have been unable to advance or even to fight a decisive battle due to the danger of an attack from the rear on lines of communication or on the troops themselves when actually engaged with an has left Greece and therefore such a danger no longer exists, there has been a massing of Entente troops in Thessaly south of the center of the line held by the Allies; the British troops have been withdrawn from the east bank of the Struma River, nominally on account of malaria but no doubt to assist in any advance that may be made. enemy at the front. But the movements of the past few days indicate momentous events in the near future and lead to the belief that an attempt to recover southeastern Serbia as far as Nish is to be made. The natural route for this would be up the valleys of the Vardar and Morava Rivers; at Nish the Berlin-Constantinople Railway would be cut and the main artery of communication and supplies for Turkey would at once be severed. Such a campaign would be the natural one under the conditions now existing in Macedonia.

Temperature Testing in the Making of Steel

THE problem of the temperature measurement and pyrometric control of furnace casting and ingot teeming temperatures is shown by a series of observations taken in several steel plants to present no serious difficulties or uncertainties. For this purpose the most satisfactory type of instrument is one of the optical pyrometers using monochromatic light and permitting observation from a distance. The necessary corrections to the observed optical pyrometer readings are sufficiently well known for the emissivity of metals and oxides but there is some uncertainty in the case of liquid slags. It is now deemed practical to determine the temperature of the charge of Bessemer converter by pyrometer methods. The operation of the open-hearth furnace can be gaged by the pyrometer; it is possible to control the temperature of the roof and of the bath of metal by observations taken through ports. Such a continuous and systematic control of open-hearth temperatures in steel and iron mills would undoubtedly make possible a greater certainity of uniformity of production, particularly as concerns quality.

Those interested in this subject will find it illuminatingly discussed in the recently published Technologic Paper, No. 91 of the U. S. Bureau of Standards, entitled "Temperature Measurements in Bessemer and Open-Earth Practice." In this paper, which may be procured by addressing the Bureau at Washington, general principles are adequately set forth, and the results of numerous series of temperature measurements in both types of furnace are given in tabular form.

INDEX

Note.—Illustrated articles are marked with an asterisk(*). Look for the general subject rather than the supposed specific titles of articles. Thus: "Aeronautics," "Automobiles," "Meteorology," "Warfare," etc., will give related articles much more quickly than by reference to the title.

(Concluded on page 656)

Exploring the Burrows of the German Army

(Concluded from page 640)

"German trench work is therefore more elaborate than ours but that does not mean that it is better. No doubt the size and overhead strength of German dugouts keep down casualties under bombardment and sometimes enable the Germans to bring up unsuspected forces to harass our men in the rear with machine-gun and rifle fire when a charge has carried us past a dugout of this kind. On the other hand when an Allied advance is made good, every man left behind in such a dugout is either a dead man or a prisoner. No doubt, again, the German trenches give more protection in very bad weather than ours. But they also remove men more from the open air and there is nothing to show that the half buried German army gains more by relative immunity from rheumatism and bronchitis than it loses in the way of general health and vitality."

The following is taken from description of W. B. Thomas of the London *Times*, of some of the German trenches captured in the Somme fight.

"Before describing the battle (Somme fight near Grandcourt and Miraumont) I must say something of the battlefield; one of the strangest, thorniest and most novel in history. The men who stormed the positions north of the river might have been advancing over roofs in a street fight. Underneath them were rooms upon rooms containing hidden and unsuspected groups of the enemy. The battlefield is still unsearched and unplumbed. Pockets of men, stores of material and reserves of ammunition lie hidden here, there and everywhere. The scale of these hiding-places is on the scale of a town of many streets and well-cellared houses. The trenches themselves are as tangled as the pattern of frost flowers on the window and the maze of crooked lines interspersed with dugout holes extends to a breadth of over a mile. A section of ground cut through Oxford Street would hardly be more intricate. The crowning marvel of German defense construction lies just across the Ancre (river) on the south side.

"If you slip along the river road you come to an opening about seven feet high in the clay cliff and when you have penetrated into this secret place you find a new world—a Monte Cristo world. Even the guns which thundered to madness outside are blurred to a murmur or are wholly inaudible. A sickly reek pervades the place, though not the reek of dead bodies. A few wounded men, vainly seeking shelter from the battle, lie where they have fallen in the passage.

"Those who first walk into this cavern have no other thoughts than curiosity or apprehension. We walk into the unknown, on and on, round one traverse into another, until the broad corridor, 7 feet high and as much in width, was cut by another of like sort leading right and left. The leg of this T-shaped avenue is about 300 yards and the arms—not yet fully explored—are at least 200. Double bedrooms and chambers of various sizes lead off from the corridor, some are papered, all are lit with electricity and the upholstery is sufficient. Paneling is frequent. How many men this barrack would house I do not know, but over 400 prisoners filed meekly out and surrendered after the fight was over. The place was used as a storehouse as well as a barrack, as we know from having found many machine guns and other trench weapons."

This last touch coming from the letter of a French soldier, is worthy of a Jules Verne.

"In really up-to-date trenches you will find kitchens, dining-rooms bedrooms and even stables. One regiment has first-class cow sheds. One day a whimsical piou-piou finding a cow wandering about in the danger zone had the bright idea of finding shelter for her in the trenches. The example was quickly followed by his comrades and at this moment the Infantry possesses an underground farm in which fat kine, well cared for, are giving such quantities of milk that butter is being regularly distributed; good butter, too."

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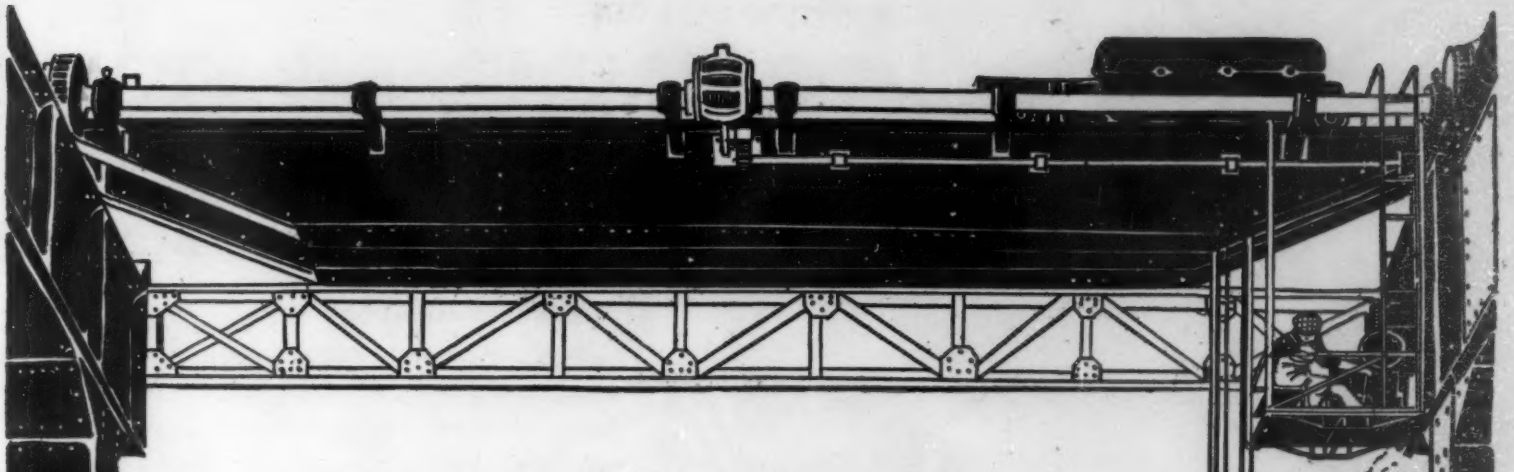

Pride and Profit

A MAN'S pride may influence his purchase of a motor car, but a motor truck he buys primarily for profit. Yet many business men who own both Pierce-Arrow cars and trucks are quite as proud of their trucks as they are of their cars. It is a different kind of pride—that is all.

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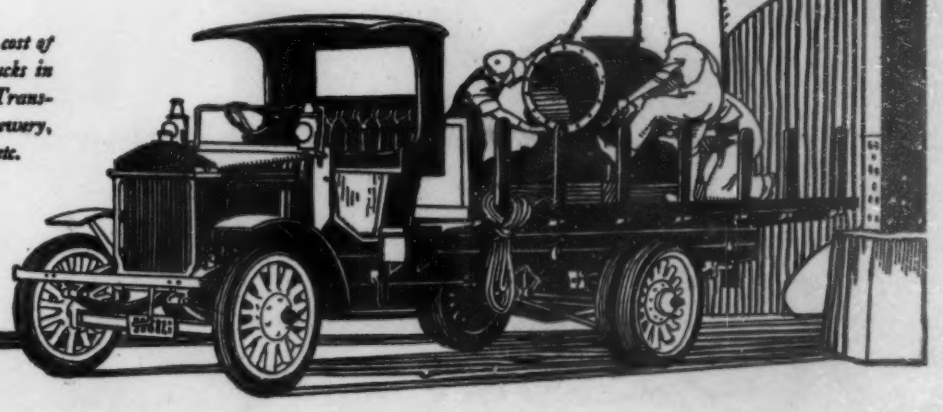


Quality makes P. A. the best partner you ever met on smoke trails!

You can hand out the pal-grip *on that* and look your man square in the eyes *and know* you are saying something *all-right!* For Prince Albert is a regular gee-wiz-z-z-ard of a smoke any way you hook-up your puff-motor to it—always on the job and geared to do sixty, down to a purr-jog under the apple trees, according to your smoke-humor! That's because P. A. has the quality! *We prefer to give quality rather than coupons or premiums!* And smokers certainly realize what *that* means!

You're all-fired glad you're a smoking man when you *get under* P. A.'s flavor and fragrance and coolness—as fine a layout of tobacco quality for generating jimmy pipe and cigarette makin's joy as you can imagine! For,

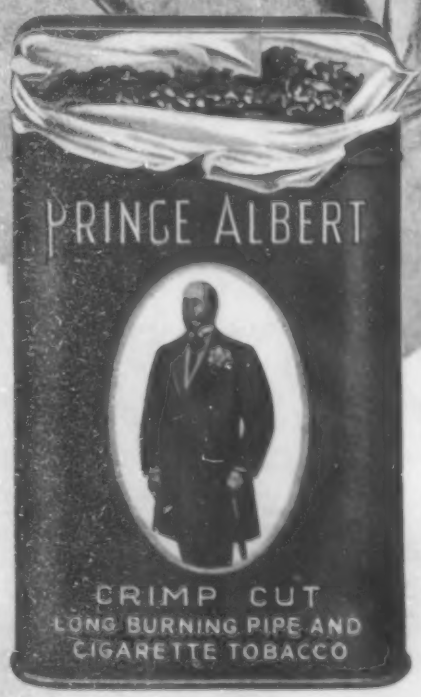
PRINCE ALBERT

the national joy smoke

tips you quick you're in right! And, you smoke away and whistle between puffs *because it tastes so good;* because it won't, *it can't* bite, no matter how much or how hard you go to it! Bite and parch are cut out by our exclusive patented process!

Get into your smoke-system that *quality* pipe or cigarette happiness that Prince Albert so lavishly spreads among its followers. Fire-up some P. A. while your spirit-feels-the spurt and get a personal howdy-do to the tobacco that men all over the civilized world have adopted as the *smoke-standard!*

For, Prince Albert caps-the-contentment climax, doling out per-puff tobacco treats that you or any other man never did quite realize could be served up to a keen smokeappetite!



Prince Albert is to be had everywhere tobacco is sold in toppy red bags, tidy red tins; handsome pound and half-pound tin humidors—and—in that clever, practical pound crystal-glass humidor with sponge-moistener top that keeps the tobacco in such perfect condition.

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